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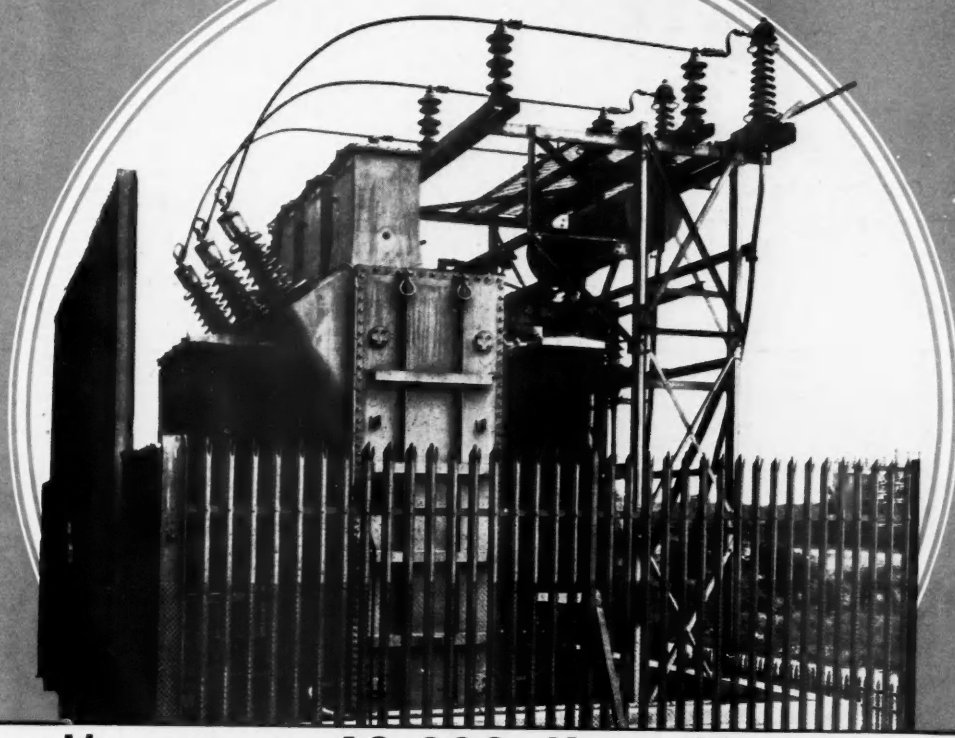
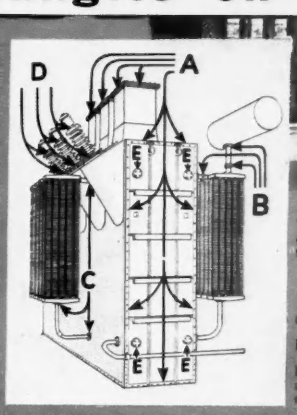
LANGITE

JOINTING MATERIAL

RESISTS OILS, SPIRITS, PETROL, BENZOL



Langite on a 40,000 Kva. Transformer



The diagram shows at A the special vertical end gasket which is a distinctive feature of this transformer.
B, the conservator tank connections.
C, the radiator connections.
D, H.T. bushings.
E, spare flanges to take extra radiators, also top covers.
All these important joints are made with Langite jointing material.
The vertical joint is a difficult joint as it holds oil to the full depth of the tank, nevertheless Langite is giving perfect satisfaction.

This photograph shows a 33 Kv. oil-immersed forced-oil-cooled transformer in the London Power Company's generating station at Willesden.

In such a transformer as this the oil-jointing problem is acute. It is interesting to note that Langite joints are used throughout.

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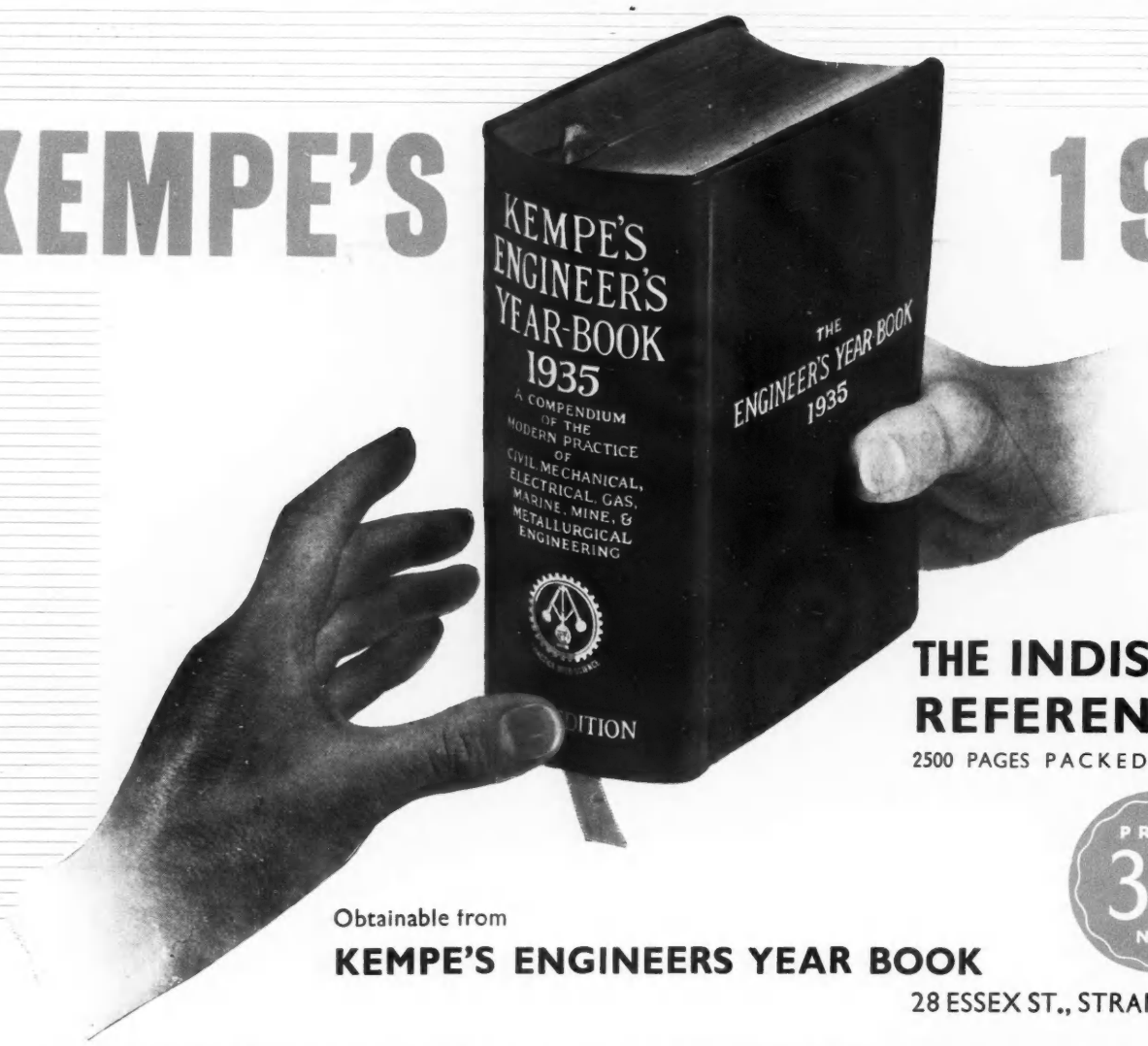
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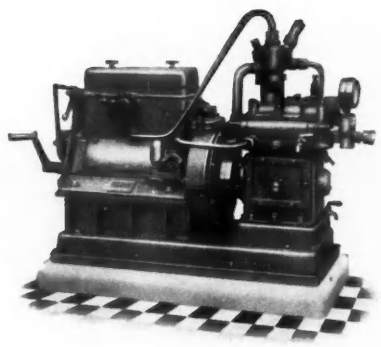
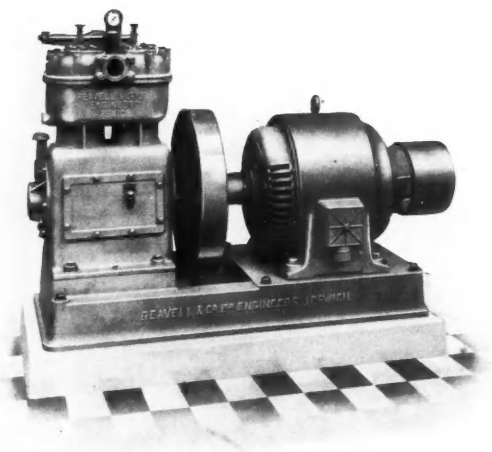
AIR COMPRESSORS

VERTICAL SINGLE - ACTING TYPE.

* * * *

Two-stage compressors, similar to that illustrated on the right, are made in two types for pressures up to 450 and 1,000 lbs. per square inch respectively. These compact and rugged machines are driven by belt, petrol or Diesel engines or by electric motors.





Single-stage machines of the type shown on the left are suitable for capacities up to 300 cubic feet of free air per minute and pressures up to 100 lbs. per square inch. They are made with one, two and three cylinders and are driven in the same way as the machines above. They are also used as vacuum pumps.

For full information write to Department "A" giving particulars of the duty required.

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A Seven-Day Journal

The Manchester Ship Canal.

THE report of the directors of the Manchester Ship Canal, which was issued at the end of last week, shows that the net receipts for the whole undertaking were £771,814, leaving a net revenue for the year of £709,804. There was an increase of £76,678 in the receipts from Ship Canal tolls, ship dues, and miscellaneous receipts, and an increase of 608,341 tons in the weight of seaborne traffic on which Ship Canal dues were paid, as compared with the year 1933. The expenditure in the working of the Ship Canal showed an increase of £3674, as compared with 1933. The surplus in the working of dock labour during the year was £965 better than that of the year 1933, while the net receipts from the company's railways showed an improvement of £6494, arising out of the increased tonnage carried over the railways. The working of the Bridgewater Canals showed a net income of £5132 for the year 1934, against £4117 for 1933, an increase of £1015. All the company's works were maintained during the year, and at the Stanlow oil docks additional oil distribution mains and valves were provided, and the system of fire protection augmented. Mr. H. M. Gibson, who was for many years the chief superintendent of the company, has been appointed its general manager, in succession to Mr. F. A. Eyres, who for reasons of health will retire from the company's service at the end of this month. In the report the directors place on record their appreciation of the eminent services rendered to the company by the late Mr. H. A. Reed, who was its chief engineer from 1912 to 1930, and its consulting engineer from 1930 until his death on January 21st, 1935.

Reorganisation in Industry.

ON Tuesday, February 19th, the Wolverhampton Chamber of Commerce had under consideration the Industrial Reorganisation (Enabling) Bill, recently introduced into the House of Lords by Lord Melchett. The provisions of the Bill to provide industries with powers for self-government, which would be obligatory upon all concerned if the majority of producers in an industry so determined, are known fairly well by most of our readers. Many of the members of the Chamber were in favour of the proposals of the Bill, and it was admitted that many industries were suffering from what could only be described as insane competition. Some measure of self-government was necessary, it was thought, if Government interference was to be avoided. It was felt that there should be some power to force a minority to come into a scheme provided that the object was the establishment and maintenance of reasonable prices. The idea that there might be some danger in the scheme was voiced by some of the members, but at the same time it was felt that industry might be compelled to adopt some form of control. The Chamber decided to take up a similar attitude to that already adopted by the Birmingham Chamber of Commerce and to refer the scheme to the Standing Committee, to watch any developments, without expressing any immediate opinion. It is of interest to record that, having in view Lord Melchett's Bill and the Bill sponsored by the Industrial Reorganisation League, the Federation of British Industries has decided to set up a special committee under the chairmanship of Sir James Lithgow, past President of the Federation, in order to consider the principles underlying the various proposals which are being advocated, and to report to the Grand Council its recommendations on the subject.

An Armament Trade Inquiry.

ON Monday afternoon last, Mr. Ramsay MacDonald, the Prime Minister, announced in the House of Commons the composition and terms of reference of the Royal Commission of inquiry into the private manufacture of and trading in arms. The members of the Commission are: Sir John Eldon Bankes, Chairman; Sir Thomas Allen, Dame Rachel Crowdy, Sir Philip Gibbs, Professor H. C. Gutteridge, Sir Kenneth Lee, and Mr. J. A. Spender. The Secretary will be Mr. Edward Twentyman, and for the present all correspondence should be addressed to him at 2, Whitehall-gardens, S.W.1. The terms of reference are divided under three headings. First, to consider and report upon the practicability and desirability (both from the national and international point of view) of the adoption (*a*) by the United Kingdom alone, (*b*) by the United Kingdom in conjunction with the other countries of the world, of a prohibition of private manufacture of and trade in arms and munitions of war, and the institution of a State monopoly of such manufacture and trade. Secondly, to consider and report whether there are any steps which can usefully be taken to remove or minimise the kinds of objections to which private manufacture is stated in Article 8 (5) of the Covenant of the League of Nations to be open, and thirdly, to examine the present arrangements in force in the United Kingdom relative to the control of the export trade in arms and munitions of war, and to report whether these arrangements require revision, and, if so, in what directions. The Royal Commission will be appointed under the usual form of Warrant giving powers to call persons before them to give evidence, to call for information in writing, and to call for and examine documents. Mr. MacDonald said that although the Commission would not specifically have power to take evidence on oath, that power would be granted if the Chairman intimated that he needed it. The sittings would be public, but not necessarily so, and the Commission would not have power to compel the Government to disclose documents contrary to the public interests.

A South Wales Coal Merger.

FURTHER progress has been made with regard to the proposal, announced early in December last, to amalgamate the undertakings of the Powell Duffryn Steam Coal Company, Ltd., and the Welsh Associated Collieries, Ltd., which together represent a combined capital of £17,000,000 with an annual possible output capacity of some 20,000,000 tons of coal. Circulars were, at the end of last week, issued to all shareholders, giving full details of the directors' amalgamation plans and calling for meetings on March 12th in order to consider them. It is proposed that a new company with the title of Powell Duffryn Associated Collieries, Ltd., be brought into being with an initial authorised share and loan capital of £7,000,000. The selling organisation of the two companies will be transferred to the new company. The memorandum issued to the shareholders states that the amalgamation offers facilities for working and opportunities for concentration of output which must inevitably result in more economical operation; these, together with the pooling of experience, the elimination of competition, with other advantages, will, it is expected, have far-reaching and beneficial effects on the earning capacity of the amalgamated undertaking. The directors of the new company are to be Mr. Edmund L. Hann (chairman), Sir John Field Beale, Mr. Edwin W. Ganderton, Mr. Douglas A. Hann, Lord Hyndley, Mr. J. H. Jolly, Sir Stephenson H. Kent, Sir David R. Llewellyn, Mr. W. M. Llewellyn, Mr. William McGilvray, Mr. H. H. Merrett, and Mr. Evan Williams.

New London Road Schemes.

THE Ministry of Transport announced on Saturday, February 16th, that it had decided, in view of the growing congestion in the streets, to make a grant from the Road Fund for work to be resumed on the North Orbital Road, which, when completed, will be the longest by-pass in England. The road, which was planned by the Ministry of Transport, is designed as an outer semi-circular route north of London, starting from the Bath Road at Colnbrook, in the west, and passing through the counties of Buckinghamshire, Hertfordshire, and Essex, terminating at Tilbury, in the east. Besides providing a clear course for traffic from east to west, it will link up the main radial routes from the capital at a distance from London of about 20 miles. One section, between the Barnet by-pass and the Watford by-pass, 10 miles in length, was constructed by the Hertfordshire County Council and opened to traffic two or three years ago, while another section 2 miles long, north of the London-Oxford Road, had been previously constructed by the Buckinghamshire County Council. The section upon which work is now to begin forms part of the intervening portion. In conformity with the other parts of the North Orbital Road, it will provide for a width of 100ft. between fences. It will have a 30ft. concrete carriageway, with footpaths on both sides. The work will be completed in about eighteen months. The Minister of Transport has also agreed to assist the Middlesex County Council to proceed at once with the reconstruction and widening of the West End Road, Ruislip, at an estimated cost of £42,000, without loss of time.

New Naval and Mercantile Orders.

IT is announced that the Admiralty has placed with Sir William Arrol and Co., Ltd., of Glasgow, an order for a large caisson for the entrance of the Singapore Dock. The contract covers not only the construction of the caisson complete, but also the supply of electrically operated hauling and deck-lifting machinery. The electrical equipment will be of the Austin constant-current type. Subject to the settlement of certain points of detail, the Admiralty has decided to entrust the construction of the two coastal sloops for the 1934 programme to Alexander Stephen and Sons, Ltd., of Linthouse, Glasgow. The projected vessels, the H.M.S. "Mallard" and H.M.S. "Puffin," will be of the "Kingfisher" class, with a displacement of about 600 tons and propelling machinery of some 3000 s.h.p., designed for a speed of about 20 knots. H.M.S. "Kingfisher," the first vessel of this class, was launched last week at the Govan Yard of the Fairfield Shipbuilding and Engineering Company, Ltd. Other important shipbuilding orders of the week include two fast cross-Channel motor passenger and cargo ships of 2500 gross tons and 320ft. in length, which have been ordered from Harland and Wolff, Ltd., by Sir Alfred Read, the chairman of Coast Lines, Ltd., for one of his associate companies. She will be built at Belfast. Abroad, orders have been placed for two timber-carrying motor vessels for the Soviet Government with the Netherland Shipbuilding Company, of Amsterdam, while the Rotterdam Drydock Company, of Rotterdam, is to build a steam oil tanker of 6000 tons D.W. capacity for Dutch owners.

A Large Bridge for China.

THE announcement was made on Friday, February 15th, that Dorman, Long and Co., Ltd., of Middlesbrough, have secured the contract for the construction of a large railway and road bridge over the Chien Tang River, at Zahow, some 5 miles from Hangchow. The bridge will consist of sixteen spans, and will be a two-deck structure carrying, on the upper deck, a 20ft. wide road with two 5ft. wide footpaths, and on the lower deck a single track of 4ft. 8½in. gauge railway. The total weight of the steel involved in the contract is, we are given to understand, about 4125 tons. The work will be begun at once, and the whole of the steel will be manufactured at the company's Middlesbrough works, and a large part of the fabrication work will immediately be begun at the company's constructional works in the same town. The new bridge is an important one and will form a rail connection between the Shanghai-Ningpo Railway and the Hangchow-King Shan Railway, while it will also provide a link between the main road to the south-east from See Shing and the network of roads radiating from Hangchow.

Engineering and Economics.

IN the course of a speech made by Dr. E. L. Burgin, Parliamentary Secretary to the Board of Trade, at a luncheon given in his honour by the Glasgow Chamber of Commerce last week, an appeal was made to Glasgow authorities to endeavour to attract lighter industries to the district in order to help out the heavy industries, which, he said, were, in times of depression, hit first. Dr. Burgin also called attention to the very high proportion of insured workpeople in Glasgow, who were employed in distributive trades. If the drift from production to distribution went too far there was a danger, he pointed out, of draining our productive industries of skilled workmen and craftsmen. Dr. Burgin further stated that, in his opinion, we were not quite at our height in engineering, in public works contracting, and in the production of prime movers for propulsion. There was much leeway to make up in British general engineering. There was still a great need for a British-designed oil engine which would use economically home-produced fuels, whether from peat, tar, or coal. Such engines were now available in Germany. One of the riddles of economics was, Dr. Burgin asserted, the fact that the highly industrialised countries like America and Germany were our best customers for exports. One reason was that the most industrialised country was the most conscious for the gaps in its industrial make up.

Progress of British Trade.

THE British Industries Fair opened on Monday, February 18th, at both the White City and at Olympia, and on Monday evening Mr. Walter Runciman, the President of the Board of Trade, took the chair at the Government dinner, held at the Mansion House, in order to celebrate its opening. This year, Mr. Runciman said, the London Fair was the largest held up to date, and covered nearly six times the area of the first Fair. In view of the decision of the Birmingham management to hold what was now to be known as the Engineering and Hardware Section of the Fair in May, it was not possible to state what the occupied exhibiting area in the Engineering and Hardware Section would finally be, but the whole of the indoor area, which totalled 265,000 square feet, had been let already. The demand for space had been so great that the Birmingham management had found it necessary to increase, from 80,000 to 200,000 square feet, the out-of-door exhibiting area to be available in May. The total occupied area of the section in 1934 was 345,000 square feet, while the exhibiting area at Birmingham already let, or in negotiation, approximated to date to 365,000 square feet. Mr. Runciman then went on to review the state of home and overseas trade, and said that the imports of raw materials had increased in value by £27,000,000 in 1934, compared with 1933. The export trade for 1934 compared with 1933 had risen in value by over £30,000,000, or more than nine times the increase recorded a year ago. The total value of the export of British manufactured goods had also risen from £282,000,000 in 1933 to £305,000,000 in 1934, an increase of £23,000,000. There had been a remarkable increase, he said, in all classes of machinery and engineering exports, among which must be recorded iron and steel goods, 17 per cent. in tonnage; machinery, 21 per cent. in tonnage, and the export of motor cars and chassis, which, in number, was 19 per cent. higher than the highest figure previously recorded. The British Industries Fair would, Mr. Runciman stated, constitute an effort to set the wheels of world trade revolving less sluggishly and would thus contribute to the recovery of not only our own industries, but those of the world.

The Development of Parsons Industrial Turbo Machinery.

No. VII.

(*Continued from page 167, February 15th.*)

Tandem Turbo-exhauster for Hot Gases.

IN 1908 the Broken Hill Proprietary Mines, Ltd., required a large gas exhauster for use in connection with an experimental process which the company wished to try on a commercial scale. The machine had to handle hot gases containing considerable quantities of sulphur and metallic fumes, including those of lead and zinc. It was also expected that grit and possibly traces of free sulphuric acid would be present in the gases. The volume of gas to be exhausted was 28,000 cubic feet per minute, and this quantity had to be delivered against a pressure of either 1 lb. or 2 lb. per square inch as might be desired.

Messrs. Parsons undertook to supply a turbo-exhauster suitable for service under the conditions imposed, and constructed the machine illustrated in Fig. 63. It consisted of a pair of similar exhausters driven by a steam turbine at 5000 r.p.m. The exhausters were capable of being connected in parallel to deliver 28,000 cubic feet per minute at 1 lb. per square inch, or in series to deliver the same amount at twice that pressure. The turbine was designed to take steam at 100 lb. per square inch superheated to a temperature of 408 deg. Fah. The governing gear was of the standard type, comprising a speed governor and a runaway governor, each controlling its own valve. A hand-operated by-pass valve on the top of the turbine cylinder

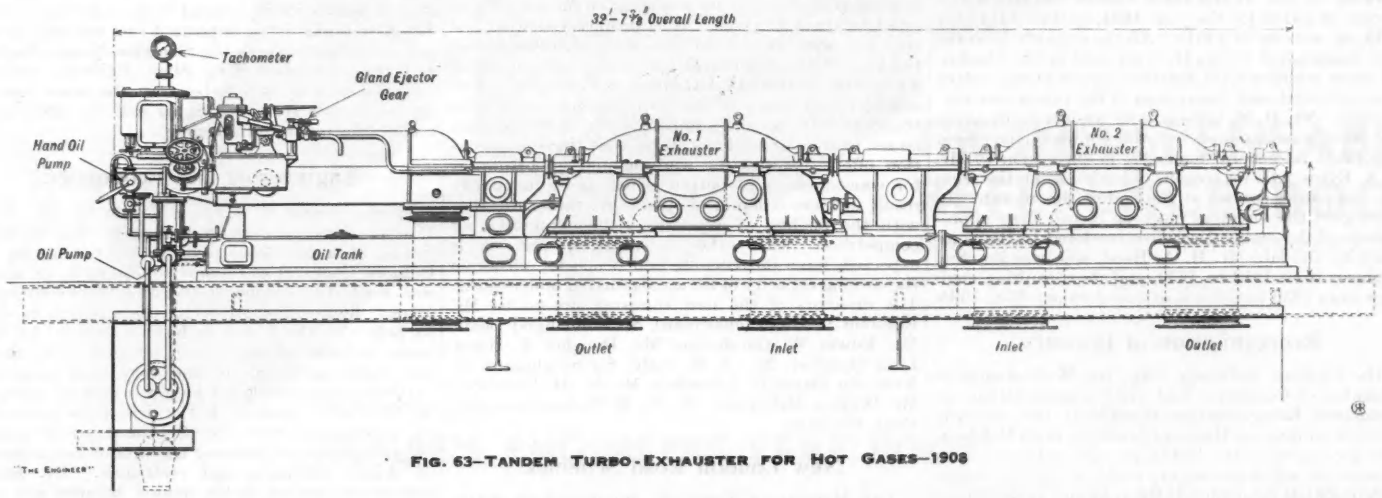


FIG. 63—TANDEM TURBO-EXHAUSTER FOR HOT GASES—1908

in diameter, and the blades projected to a height of 6·25in., making up the overall diameter of 23in. and giving a tip speed of 500ft. per second at the normal speed of the machine. The blades were made of forged steel, as no brass or similar alloy could be used inside the exhauster on account of the deleterious nature of the gases to be handled. For the same reason the glands were made of mild steel bushes lined with lead, in which sharp-edged grooves were cut. These grooves were arranged in four groups of four each, and they engaged with corresponding rings turned on the shaft. Details of one of these glands are given in Fig. 66, and a photograph of one of the exhausters with the cover lifted showing the fans and guide vanes in position is reproduced in Fig. 64.

The two exhausters drew in gas at their adjacent ends, so that the flow through the machines was in opposite directions. The end thrusts of the rotors, therefore, opposed each other, and by making the shaft ends butt together, the thrusts were mutually neutralised. As a measure of security, and to ensure the accurate axial location of the rotors, a multi-collar thrust block was fitted at the inboard end of the machine farthest from the turbine.

Reference to the general arrangement drawing, Fig. 63, will show an interesting method of supporting the exhauster cylinders. These were bolted to side brackets brought right up to the level of the centre line of the machine, so that any longitudinal expansion of the cylinders could take place without the tendency to produce distortion which might have been feared had the attachment been made by feet in the usual position. This precaution was taken in view of the fact that the gases might sometimes have a temperature as high as 500 deg. Fah., and, of course, the whole length of the cylinder would then be exposed to this temperature. It is worth recording this early adoption by Sir Charles Parsons, of the principle of supporting a cylinder at the height of its axis in order to avoid distortion due to temperature changes, because of recent years certain Continental turbine manufacturers have claimed novelty for the same idea.

The exhauster, having served the experimental purpose for which it was built, was no longer required, and in 1910 the turbine was removed and coupled to a 250 kW, three-phase Parsons alternator, to make an electric generating unit. For this purpose its speed was diminished to 3000 r.p.m., suitable alterations being made to the governing gear, &c.

The First Centrifugal Air Compressor.

Amongst the more interesting applications of the exhaust steam turbo compressor must be mentioned a case in which the output of an existing reciprocating air compressing plant was doubled by the use of such a machine, without any increase either in the fuel consumed or in the boiler plant employed. The Burradon and Coxlodge Coal Company, Ltd., had in service, at their Hazelrigg Colliery, near Newcastle-on-Tyne, two steam-driven reciprocating compressors, each delivering about 1000 cubic feet of air per minute at a pressure of 80 lb. per square inch. The engines exhausted to the atmosphere. There was an obvious economy to be effected by developing power from the exhaust steam, and in 1909 Messrs. Parsons undertook to utilise this waste energy in such a manner as to enable the existing compressors to deliver twice the previous quantity of air at the required pressure of 80 lb. per square inch.

To do this they constructed an exhaust steam turbo-compressor capable of taking in 4000 cubic feet of free air per minute and delivering it at 20 lb. pressure. This air was led to the cylinders of the reciprocating

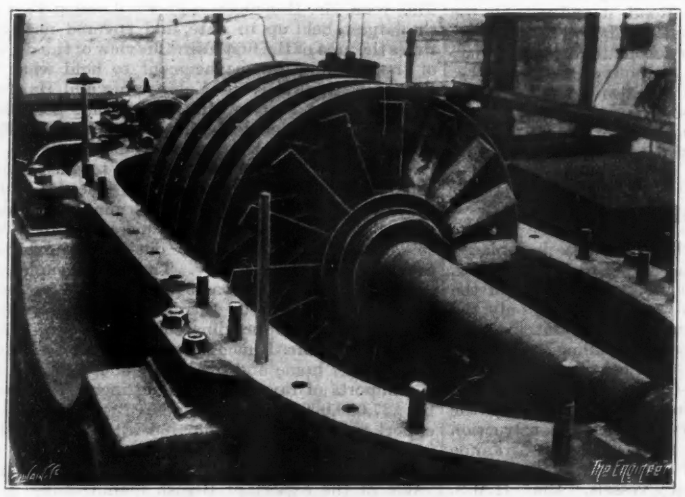


FIG. 64—EXHAUSTER WITH COVER LIFTED

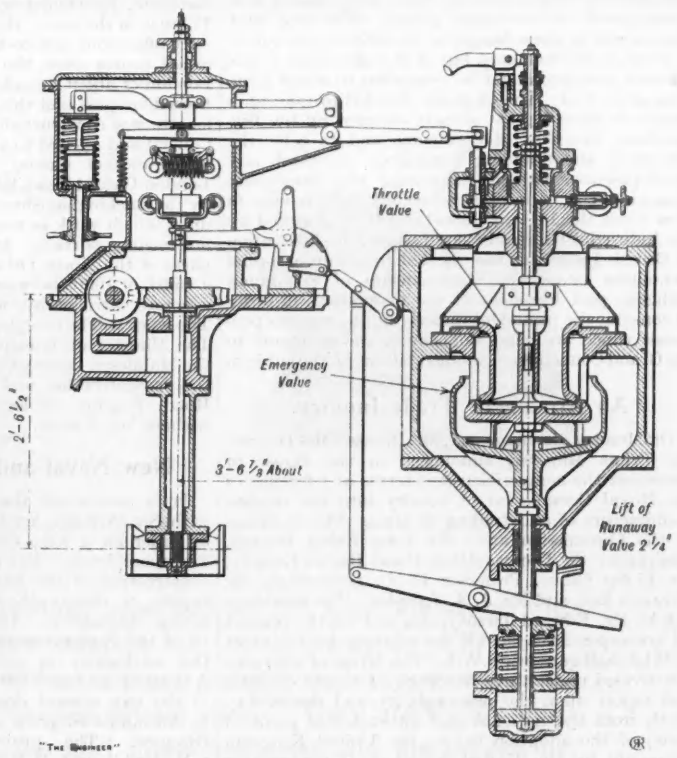


FIG. 65—SECTION THROUGH VALVE GEAR OF "HAZELRIGG" MACHINE

compressors, in which it was further compressed to 80 lb. per square inch. The reciprocating machines could, of course, deal with the increased quantity because its volume was reduced by the initial compression. The combination was particularly advantageous, as both the exhaust steam turbine and the turbo-compressor were operating with pressures and volumes that could not be effectively handled by piston machinery. Working in conjunction with the steam and air cylinders of the reciprocating machines, the exhaust turbine and its compressor constituted a self-contained and highly efficient steam-driven compressing plant.

The exhaust steam turbine was designed for an output of 350 b.h.p. at 5000 r.p.m. It was controlled as usual, by both speed and runaway governors, which, as will be seen from Fig. 65, were both carried on the same spindle. A change was, however, made in the valve arrangement. It had been the custom previously to fit separate runaway and throttle valves in the same steam chest, side by side, but in the Hazelrigg turbine a combination of these valves was adopted. Referring again to Fig. 65, it will be seen that the steam entering the chest had to pass first through the runaway valve before reaching the throttle valve, in accordance with the usual practice. The runaway valve was of the double-beat pot type and closed by moving upwards against two seats formed on the outside of the cage holding the throttle valve. The closing of the runaway valve thus prevented any steam from entering the throttle valve, and so shut down the turbine independently of any action of the latter valve.

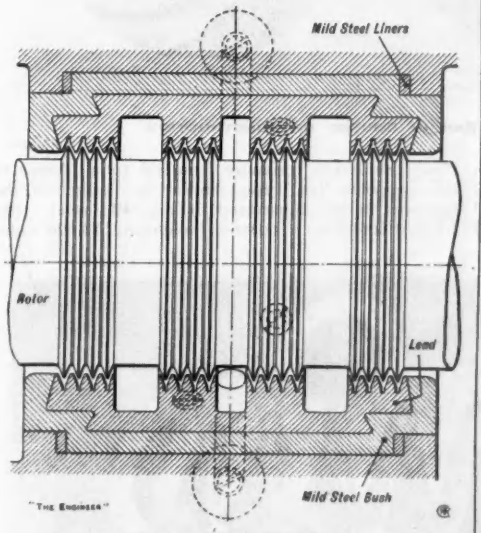


FIG. 66—GLAND OF TURBO-EXHAUSTER

The speed governor actuated the throttle valve by means of the ordinary steam relay mechanism of the period. The valve was opened by the pressure of steam beneath a spring-loaded piston fixed at the upper end of the valve spindle. This steam was constantly admitted by a small needle valve. Its escape, and therefore the pressure under the piston, was controlled by a relay plunger, kept in continuous oscillation by the governor mechanism. The mean position of this plunger was determined by the height of the governor sleeve. If the load on the turbine increased the consequent slight drop in speed caused the plunger to oscillate about a lower mean position and thus to shorten the duration of each escape of steam from beneath the relay piston. The average pressure under the latter was therefore increased, with the consequence that the piston was raised and the throttle valve opened more widely. The continuous oscillation of the governor lever and relay plunger kept the whole of the mechanism "alive" and ready to respond instantly to the slightest change in the load without any danger of sticking.

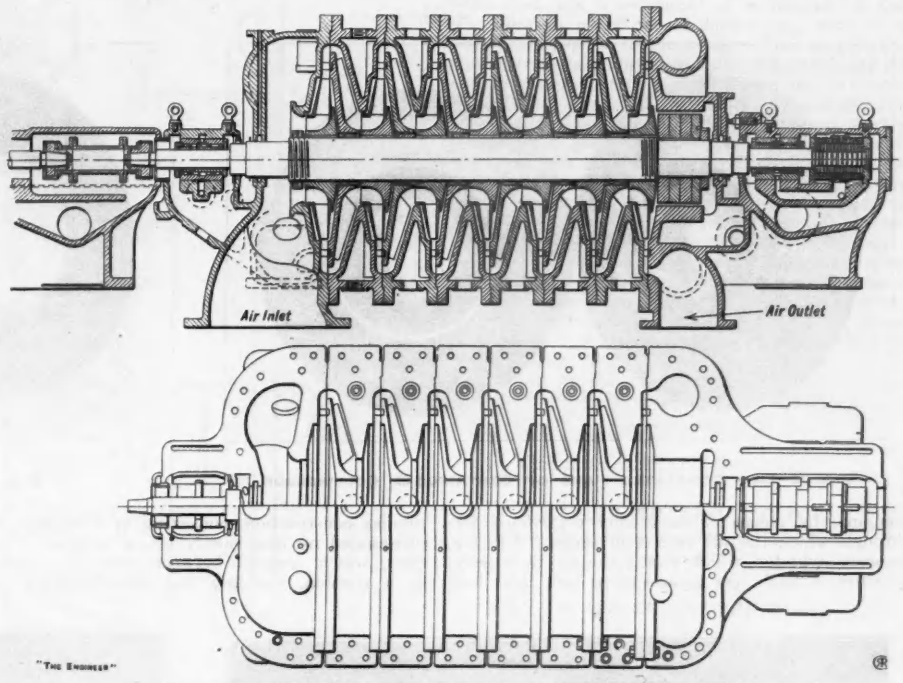


FIG. 68—SECTION THROUGH "HAZELRIGG" COMPRESSOR—1909

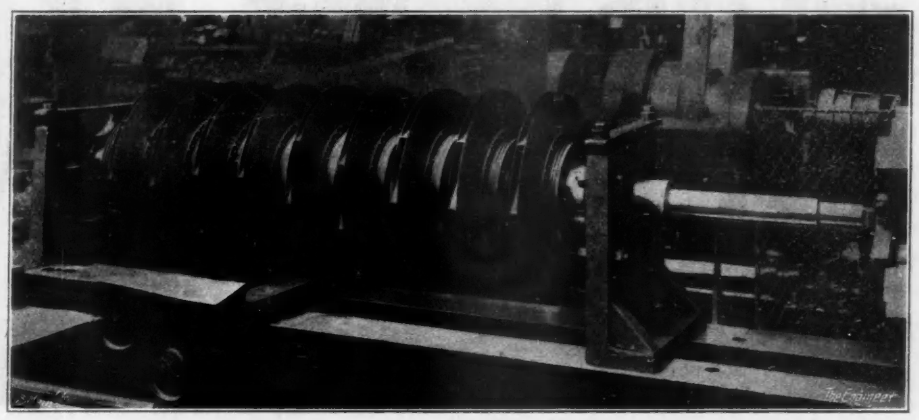


FIG. 69—HIGH-PRESSURE ROTOR OF TANDEM CENTRIFUGAL COMPRESSOR—1909

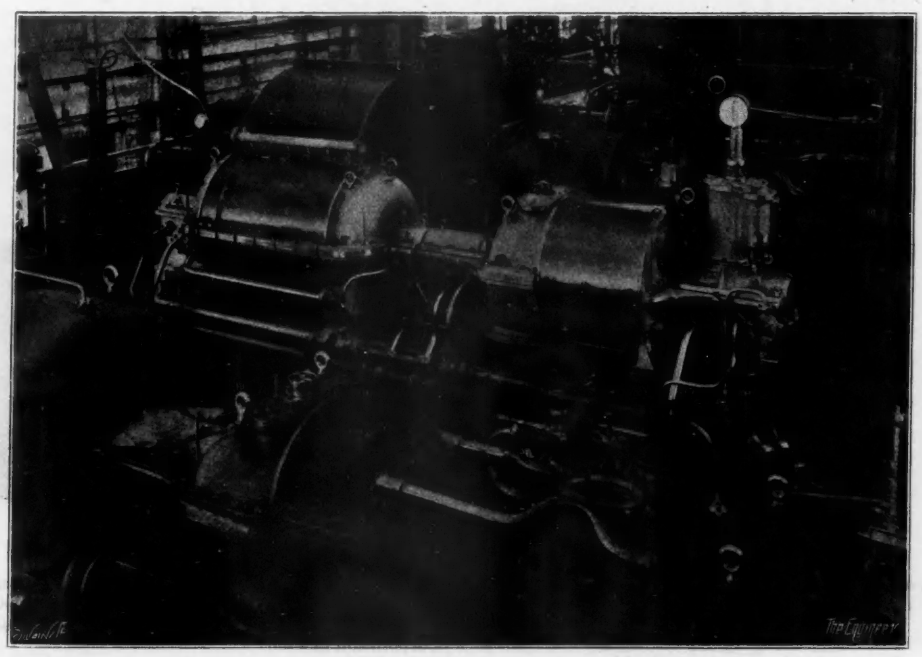


FIG. 67—"HAZELRIGG" TURBO-COMPRESSOR—1909

The turbo-compressor was noteworthy as being the first machine of its kind to be constructed at Heaton on the centrifugal principle. All previous turbo-compressors had consisted essentially of a number of impeller fans in series, giving a pure axial flow of the air through the machine. The Hazelrigg compressor, on the other hand, developed pressure in the air by its centrifugal force, on the same principle as that employed in centrifugal pumps to create a water pressure. Its construction, therefore, bore a considerable resemblance to that of a centrifugal pump of the multi-stage type, as will be evident from the sectional drawing reproduced in Fig. 68. The air was cooled by water jackets between the various compartments containing the impellers. The cylinder was of the built-up construction, with a separate casting for each impeller, and the joints between the castings were so arranged that they did not occur in the water chambers. The water entered each chamber at the bottom and left at the top, the inlet and outlet connections being shown in the drawing. A built-up dummy piston consisting of four discs mounted on the shaft served to balance the end thrust, any excess pressure being taken by the multi-collar thrust block shown on the extreme right-hand side of the drawing. A photograph of the turbo-compressor erected in the Heaton Works before delivery is reproduced in Fig. 67.

THE FIRST TANDEM TURBO-COMPRESSOR.

Consistently with their policy of checking the calculations and designs of a new type of machinery by large-scale experiments before undertaking its commercial development, Messrs. Parsons constructed a tandem centrifugal compressor to their own order in 1909. This was the first tandem compressor to be built at the Heaton Works, and until its services were more urgently wanted elsewhere during the war, it was used for providing experimental data for the design of further machines. It was itself designed for the normal duty of delivering 5000 cubic feet of free air per minute at a gauge

pressure of 65 lb. per square inch when running at 5000 r.p.m. As will be seen from the sectional drawing, reproduced in Fig. 75, it consisted of separate low and high-pressure cylinders arranged in line. The work of compression was done, as in the Hazelrigg machine, by means of single-inlet centrifugal fans through which the air passed in series. The low-pressure cylinder, which raised the air to a gauge pressure of 25 lb. per square inch, had eight fans, while the high-pressure cylinder effected a further compression to 65 lb. by means of nine fans. All the fans were 12in. in diameter, their widths diminishing, however, in proportion to the increasing density of the air which they had to handle.

Each compressor cylinder was built up of separate sections, made in halves and bolted together, the number of sections corresponding to the number of fans. These sections contained the passages leading the air from the outlet of one fan to the inlet of the next. They also carried a ring of fixed guide blades projecting horizontally over the circumference of each fan to restore the radial flow of the air. Each section contained its own water chamber for cooling purposes, the water entering at the bottom of the lower half of the section, passing upwards through holes in the metal of the horizontal joint faces, and so out at the highest point of the cylinder.

The appearance of the high-pressure rotor is illustrated in Fig. 69. Two of the fans are shown separately in Fig. 70, and one in course of construction in Fig. 71. The bosses of the fans were of cast steel. One side of the boss was curved down to a smaller diameter for the entrance of the air to the fan, while to the other side was riveted a steel cheek. The other cheek had a large central eye stiffened by an angle ring riveted round it. The two cheeks were held together by rivets passing through the thickness of the internal vanes. These were ten in number, and were curved as shown in the photographs. Alternating with the rivet holes through the vanes were other holes drilled through the metal in order to reduce the weight and, therefore, the centrifugal force of the vanes. These holes are very evident in Fig. 71.

Reverting to the sectional drawing of the complete machine, it will be seen that the air flow was in the same direction in both cylinders. As the two rotors were connected by a flexible coupling, it was therefore necessary to balance the end thrust of each of them separately. This was done by a dummy piston, built up of four discs and mounted on the shaft as shown. Each rotor was also provided with a multi-collar thrust block to take care of any residual end pressure. The rotor bearings were of tubular construction, consisting of a working bush surrounded by two loosely fitting sleeves. The oil films which existed between the sleeves served as a cushion, enabling the shaft to align itself and to run at high speeds without vibration.

The compressor was kept by Messrs. Parsons for experimental purposes until 1915, when it was coupled to a mixed-pressure turbine and the set sold for commercial duty to the Cannock and Rugeley Collieries Company, Ltd., Staffordshire.

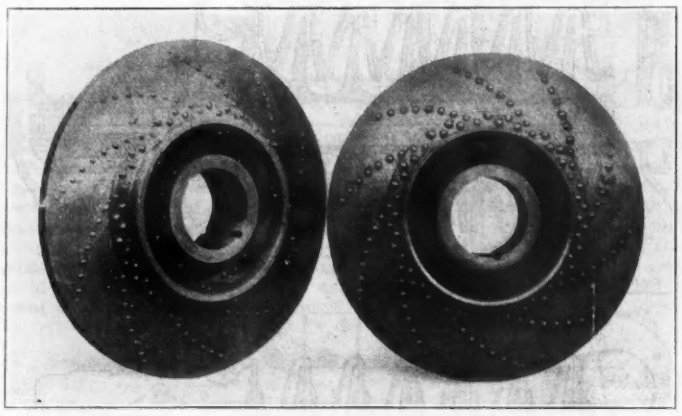


FIG. 70—TWO COMPLETED FANS OF CENTRIFUGAL COMPRESSOR

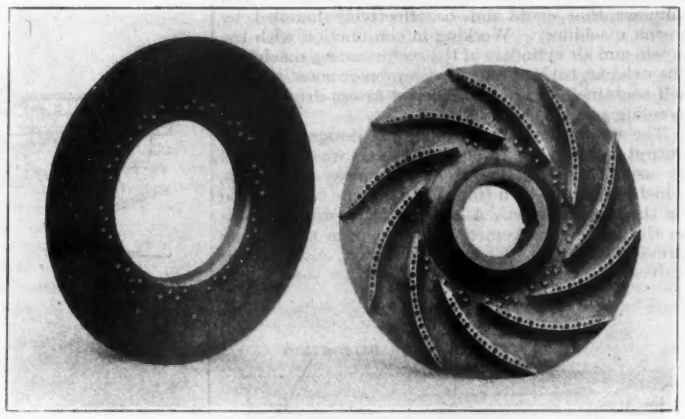


FIG. 71—FAN IN COURSE OF CONSTRUCTION

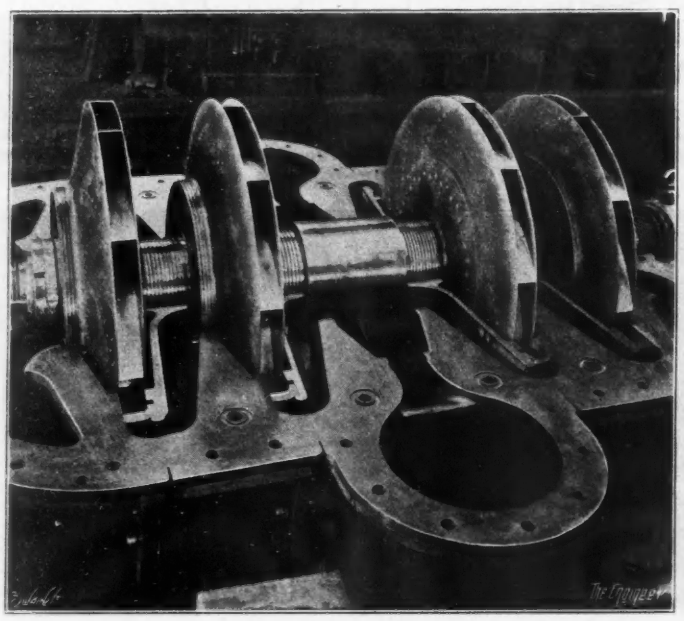


FIG. 72—BLOWER FOR SYDNEY WITH COVERS REMOVED

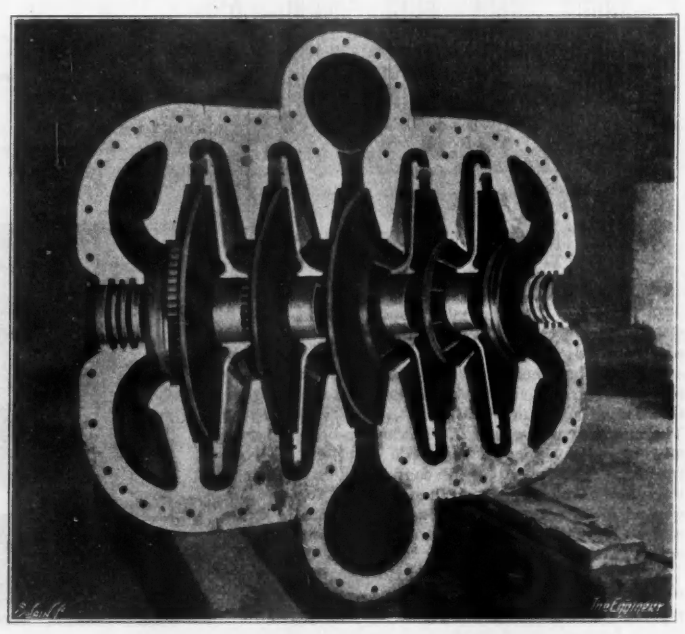


FIG. 73—TOP HALF CASING OF BLOWER

TURBO-BLOWERS FOR GASWORKS.

The application of the turbo-blower to gasworks duties dates from 1904, when a machine of this kind was constructed for the Glasgow Corporation. It was used for drawing town gas from one of the large holders at the Provan Gasworks and pumping it downhill to the Dalmarnock Works. The unit consisted of a non-condensing turbine working with steam at 100 lb. pressure, coupled to a blower of the propeller fan type, similar in design to the Coltness blower illustrated in Fig. 42 (*ante*). The blower acted as a booster, delivering 13,500 cubic feet of gas per minute and producing a pressure increase of 24in. w.g. Its normal speed was 8000 r.p.m. The speed governor of the turbine was belt-driven from a worm wheel shaft, and acted directly on the throttle valve without the intervention of a steam relay or a lever train. A second unit of the same design and capacity, was supplied to the Glasgow Corporation in 1905.

In 1909 a pair of turbo-blowers was built by Messrs. Parsons for the Sydney Gasworks in New

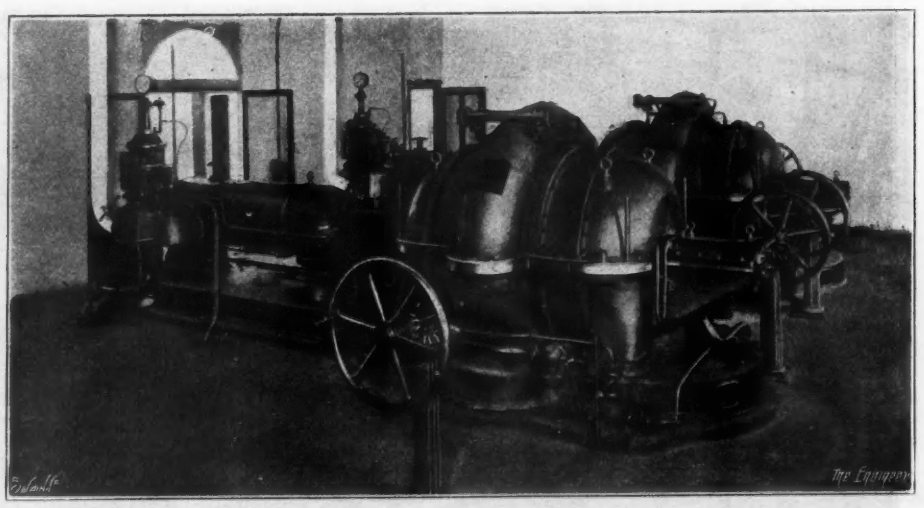


FIG. 74—TWO TURBO-BLOWERS IN SYDNEY GASWORKS—1909

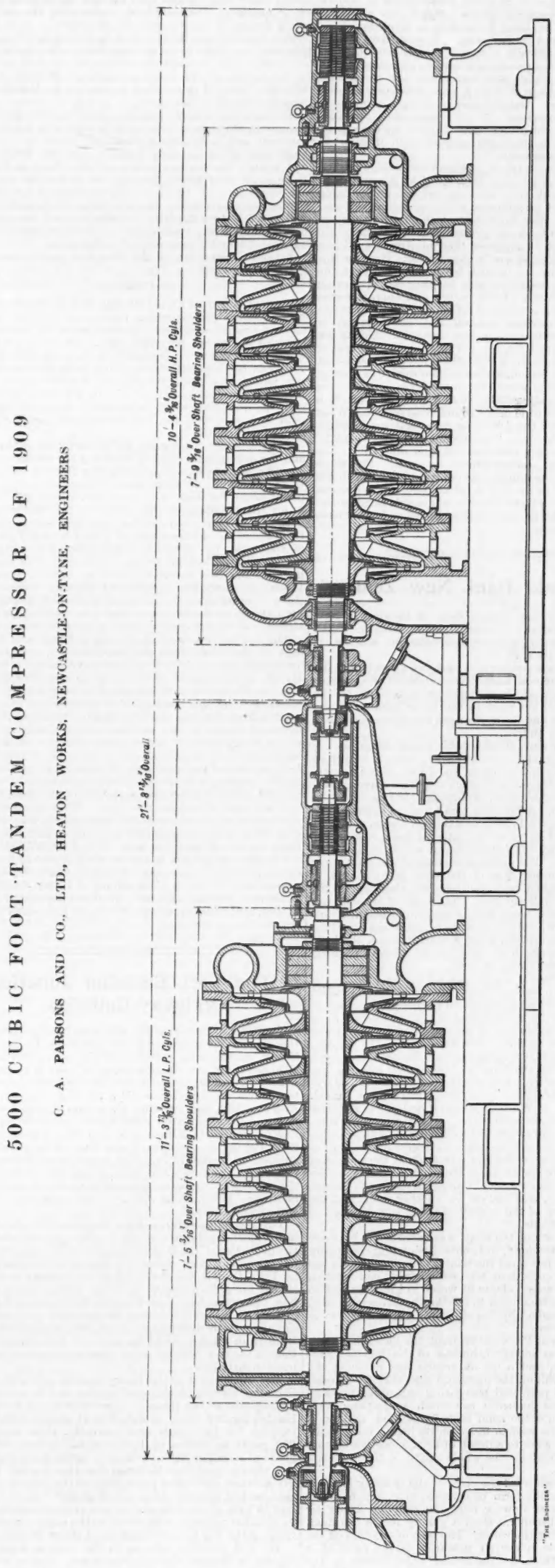

5000 CUBIC FOOT TANDEM COMPRESSOR OF 1909
C. A. PARSONS AND CO., LTD., HEATON WORKS, NEWCASTLE-ON-TYNE, ENGINEERS
10'-4 5/16" Overall H.P. Cyls.
7'-9 7/16" Over Shaft Bearing Shoulders
27'-8 15/16" Overall
11'-3 13/16" Overall L.P. Cyls.
7'-5 3/16" Over Shaft Bearing Shoulders
"THE ENGINEER"

FIG. 75—LONGITUDINAL SECTION THROUGH TANDEM COMPRESSOR

South Wales. Each of these was required to deliver 17,000 cubic feet of gas per minute against a water gauge pressure of 56in. They were driven by steam turbines, which took steam at a pressure of 150 lb. per square inch superheated to 466 deg. Fah. and exhausted into a condenser at a vacuum of 28in. The blowers, which ran at 3380 r.p.m., were of the centrifugal type in this instance. They were double-ended, the gas entering at each end and being discharged at the centre of the cylinder by two centrifugal fans in series on each side. A photograph of one of the blowers with its cover removed to show the essential parts, is reproduced in Fig. 72, while the upper part of the cylinder is shown in Fig. 73.

The construction of the fans was similar to that already described in connection with the experimental compressor, except that the flanges around the fan eyes were solid with their cheeks, instead of being riveted on. In spite of the low pressure required to be developed by the blowers, they were water cooled, each section having its own water inlet and outlet. The holes through which the water flowed from the bottom to the top half of each section are clearly visible along the joint facing in Fig. 72. A photograph of the two machines installed in the Sydney Gasworks is reproduced in Fig. 74.

(To be continued.)

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

LEVERS AND THEIR TERMINOLOGY.

SIR,—Having had occasion recently to deal with a small problem involving levers, an idea occurred to me which I think may be of some interest to your readers.

We have all been accustomed in this connection to the terms "mechanical advantage" and "levers of the first, second, and third orders." If we consider the former, we find that since the science of mechanics deals with distance, force, and time, no definite meaning is conveyed by the term "mechanical advantage." Would it not be better to divide levers into two main classes, viz., those with "force" advantage, and those with "distance" advantage?

Turning now to the "orders" of levers, a similar ambiguity is apparent from a study of the following statements:—

(1) A lever of the first order—

(*a*) May have either force or distance advantage.
(*b*) Has its "effect" acting in a sense opposite to that of its "cause."

(2) A lever of the second order—

(*a*) Must have force advantage.
(*b*) Has its "effect" acting in the same sense as its "cause."

(3) A lever of the third order—

(*a*) Must have distance advantage.
(*b*) Has its "effect" acting in the same sense as its "cause."

From this we see that a lever of the first order is a combination of orders 2 and 3, and that orders 2 and 3 must therefore be the same lever differing only in the nature of the "advantage."

Summarising the above, it may be stated that levers are dependent on two variables:—(1) The nature of the advantage; (2) the phase relationship between the "cause" and the "effect."

Thus—

A lever of the first order is a 180 deg. lever
" " second " 0 deg. " (force advantage)
" " third " 0 deg. " (distance advantage)
A right-angle bell-crank lever is a 90 deg. lever

Based on the old assumption that a 2 : 1 lever means a lever of 2 : 1 force advantage, the following system of designation might be used:—

1 : 3 lever, first order = a 180 deg., 1 : 3 lever.
2 : 1 " second " = a 0 deg., 2 : 1 "
1 : 4 " third " = a 0 deg., 1 : 4 "
1 : 2 " (150 deg. bell-crank) = a 150 deg., 1 : 2 lever

The above method would, I believe, be of considerable value from an educational standpoint, and would undoubtedly simplify the work involved in compound or multiple lever systems, where, to obtain the final result, the angles could be added and the ratios multiplied together.

J. C. BARNES,
M.A., Sc., University of Toronto.
Toronto, Ont., January 28th.

TEMPERATURE OF I.C. ENGINE INLET VALVES.

SIR,—It is not generally realised how exacting are the heat conditions that pistons and valves have to withstand, and an experience of our chief engineer, who recently visited the test-house of a well-known firm of Diesel engine builders, may enable your readers to appreciate the success of the metallurgical chemist in evolving metals that will stand up to high temperatures for long periods.

During his inspection, our chief engineer noticed a

phenomenon regarding which we have not seen any mention made previously.

On one engine the air intake manifold had been removed for convenience, and it was therefore possible to see the underside of the inlet valves, all of which were dull red. The engine was carrying a normal load and the speed was only 1200 r.p.m.

The designer stated that the inlet valves always attained red heat and volunteered the opinion that the incoming air was insufficient to keep the valves cool. He added that on this particular design of engine the exhaust valves did not attain the heat reached by the inlet valves.

In the light of this experience, it is hardly surprising that valve seats are usually the first part of an engine to require the attention of the welding engineer.

BARIMAR, Ltd.,
C. W. BRETT, Managing Director.

London, W.C.1, February 15th.

Electrical Progress in America.

STEADY progress in electrical practice is more or less universal. Just as every year brings to light new developments in this country, so are advances made in America and elsewhere. While great inventions and discoveries are separated by long intervals, the tendency to improve existing equipment and to utilise newly acquired knowledge is continuous. Annual reviews of electrical work do not, it is true, always reveal many outstanding changes in design, but as the years pass and accumulated experience is put to account, it is not difficult, on looking back, to discover in what directions important progress has been established. The familiar curve showing how the steam consumption of the Parsons steam turbine has been reduced since that machine was invented affords a good example of how engineers gradually succeed in improving their products. Different countries have their own specific problems, which sometimes cause them to give a lead to others. Unlike this country, America, for example, has not abandoned single-phase traction, nor its natural tendency to produce the largest machines in the world. Hence it is not surprising to learn from the American General Electric Company's report on electrical developments during 1934 that the largest single-phase water wheel generator ever built was completed during that year for the supply of power to an electrified extension of the Pennsylvania Railway. Rated at 35,000 kW, 13,300 volts, and 25 cycles, the machine has a heavy damping winding and is spring mounted to prevent transmission of vibrations resulting from the pulsating torque to the foundations. For the same railway, which at the moment is the only one in America that is adding to its electrified mileage, a new streamlined electric locomotive was built and tested at speeds up to 100 miles. Efforts of the railways to increase passenger traffic stimulated the use of oil-electric railcars which are constantly being improved, and increased horse-power per unit of weight coupled with better reliability indicate the possibility of their adoption in the near future for main line traffic. As in this country, the use of trollybuses, or coaches, as they are called in America, was extended, while electric tramway progress was perhaps best exemplified by the supply of new cars to Chicago, designed for exceptionally high rates of acceleration and retardation without discomfort to passengers. A new type of road vehicle can be operated, at will, either as a trollybus or as a petrol-electric vehicle.

In the field of marine electrical engineering the most notable development, apart from propulsion, was perhaps the launching of a naval destroyer on which practically all the auxiliaries are driven by A.C. motors. Reduction in weight, increased reliability and simplicity of the electrical equipment are the advantages claimed for the new scheme, which will probably be applied to other vessels in the future. Recent American steam turbine practice, so far as it is revealed by the report under consideration, does not represent anything very revolutionary. Of the machines at present under construction, one of the most interesting is a 110,000-kW, 1800 r.p.m. vertical compound unit, designed for a pressure of 1200 lb. per square inch and a temperature of 900 deg. Fah. Composed of a high-pressure cylinder and generator mounted above a low-pressure cylinder and generator, it is the second machine of the kind ordered by the Ford Motor Company, which is apparently anxious to save space and foundation costs.

While no new mercury vapour boiler and turbine installations were put into service during 1934, those at Hartford, Kearney, and Schenectady seem to have given satisfactory service, although in the case of Kearney boiler difficulties necessitated certain alterations. All fluids such as salts, hydrocarbons, and refrigerants, which seemed to offer any likelihood of increased economy in central stations, were investigated, but none proved to be more efficient than mercury. Record breaking was perhaps best exemplified by the building of the highest voltage heavy duty switches ever constructed, for use on the 287,500-volt transmission line from the Boulder Dam to the city of Los Angeles. Built on the impulse principle, these circuit breakers bear little resemblance to orthodox tank units, and although designed for a rupturing capacity of no less than 2,500,000 kVA, contain a small quantity of oil, which is driven through the arc under pressure. New records were also established in connection with the Boulder Dam scheme by the building of the first 82,500-kVA three-phase water wheel generator, weighing more and having greater dimensions than any water wheel generator now in service, and by the construction of seven 287,500-volt, 50,000-kVA transformers. Thyratron and phanotron valves are reported to have made it possible to couple non-synchronous systems without the aid of machines. Better stability is said to be secured than that obtainable under ordinary conditions, whilst faults result in a reduced power flow. But to what extent the scheme has met with practical application the report does not state. Although much is written, in these days, about the possibility of using static apparatus for such purposes as frequency changing and the conversion of D.C. to A.C., up to the present developments of this kind appear to have been mainly confined to experimental workshops and laboratories, although mercury arc inverters and frequency changers are reported to be under construction for service on Continental electric railways. Many new electrical instruments were produced for service in laboratories, on power systems, and in industry. New electric lamps, including a high-intensity mercury vapour unit, used in combination with an incandescent lamp to give illumination approximating daylight, were introduced and there were additional installations of sodium vapour lamps for street lighting. Motors, transformers, voltage regulators, refrigeration equipment, X-ray apparatus, wireless apparatus, and power cables are all covered by the report, which shows that in practically every branch of electrical practice progress was made.

But if American electrical engineers have distinguished themselves in one way more than another, it surely is in the amount of work they have carried out on lightning and its associated phenomena. The many papers and reports that have been published on this subject are apt to lead those who have not given much attention to the matter themselves to suppose that in America all the requisite knowledge has now been acquired. How far this conclusion is from the actual truth can, however, be gauged from the researches now in progress. Believing that a thorough study of the nature and characteristics of natural lightning is essential before further advance can be made, the American General Electric Company is extending its investigations in that direction. Among the equipment developed for the purpose, such as a special camera and oscillograph, is a 265,000-ampère, 150,000-volt impulse generator, which, on the sudden release of energy, will reduce a block of wood to splinters, shatter a concrete beam, vaporise small sections of iron wire, or crumple a metal strip an inch wide into a round cross section. What the total cost of all the American investigations amounts to is probably unknown. The amount of money spent by manufacturers, supply undertakings, and others in trying to solve lightning problems must be great. For surge investigations in this country the Central Electricity Board has made a grant to the E.R.A. of £21,000, but it remains to be seen to what extent the sum will enable the Association to provide the information the Board and other electrical people require.

The Waitaki Dam, New Zealand.

ALTHOUGH not the largest dam of its kind in New Zealand, the Waitaki (Oamaru, South Island), which forms the basis of a new hydro-electric scheme, is notable amongst its kind.

Boring operations and surveys took two years before the present site was chosen, mainly on account of the expanse of graywacke rock which stretches from the hills on the Canterbury side of the river to the lower country on the North Otago side, and forms the solid foundation on which the dam has been built.

It is a gravity dam of monolithic construction, and is built on a compound circular curve, with a radius of 2000ft. on the North Otago side, and 750ft. on the Canterbury side. The monoliths of which it is built average 55ft. in width, and have bitumen expansion joints radial to the curve of the dam. A bitumen core prevents leakage.

Over all, the dam is 1730ft., or a third of a mile, in length, and incorporated in it as an integral part is a power house, 350ft. long, the foundation of which is a part of the dam proper. The spillway section of the dam, over which all the unused flow of the river is by-passed, is 1160ft. long, flanked on either side by abutments 12ft. higher than the spillway level. The crest of the spillway is 753ft. above sea level, with a maximum height above river level of 120ft., with an average height of the river bed, however, only about 70ft. while it extends below the level of the river to a depth of 35ft. At its deepest part the spillway has a base width of 144ft.

The Waitaki dam is not as high as the Arapuni, in the North Island, an arched dam, but it is much longer, having been curved and lengthened purposely to obtain an adequate length of spillway for the discharge of flood waters and for the leading of the necessary head of water to the penstocks on the North Otago side. In its construction about 230,000 cubic yards of concrete were used.

One of the big problems at the outset was the dewatering of the river, which could not be achieved, as was the case with Arapuni, by diversion through a tunnel. It was necessary at Waitaki to cut off sections of the river by means of three cofferdams, which were, in turn, pumped dry, and excavated to rock bottom to allow of the building of the monolithic sections comprising the wall of the dam. The first cofferdam was built in the middle of the stream and provided one of the most hazardous undertakings of all. Then the South Canterbury side, the deepest part of the river, was cut off by another dam, and the whole of the flow of the mighty Waitaki was diverted to the North Otago side.

The greater part of the work was carried out by three eight-hourly shifts daily, but, notwithstanding the steady progress, it was not until the winter of last year that the third and last cofferdam was successfully constructed. Once again the huge volume of water in the river had to be diverted, this time back to the South Canterbury side, where it was handled by the sluiceways in the section of the dam completed.

On the advice of Professor Hornell, the Swedish expert, a cut-off wall was added to the base of the dam as a protective measure, and a cut-off trench was made at the bottom of the wall on the upstream side, thereby increasing the seepage path and preventing any uplift pressure of water. Then immense saw-tooth projections were added, fitting into the solid rock foundation, making it impossible for the wall to move on its base. Later came the cut-off wall, sunk to a depth of 20ft. below the bottom of the river throughout the whole length of the upstream face of the dam.

A few feet down from the crest of the spillway is a line of projections in the form of inverted vees, which act as disrupters. Water flowing over the spillway draws air through these disrupters from a gallery inside the dam, the air emulsifying the water. The base of the dam on the downstream side is curved upwards in the form of a bucket, from which the emulsified water passes to the river in its normal state. Between the spillway section and the power-house are two permanent sluiceways for use in controlling the flow over the spillway in flood times, or, if necessary, for completely dewatering the spillway when repairs or observations are necessary.

Two inspection galleries run through the upper part of the dam, and there is yet another 50ft. below the level of the river, which provides access from one bank to another in the bowels of the earth beneath the Waitaki River. The floor level of this gallery is reached by ladders, the longest of which is 70ft. deep.

Through last winter, with the dam completed, eleven temporary sluiceways were used to cope with the flow of the river, and in July six of these were closed by lowering huge steel gates on steel runners over the sluiceways, and sealing the cavities with concrete. Late in August three more were sealed, leaving two sluiceways to take the whole flow of the river. It was toward the end of September that the last two sluiceways were sealed, and within a few days the lake had filled up and was running over the spillway, presenting the outward signs of the successful completion of a great undertaking.

Several illustrations of the dam and power-house are given on page 200.

COST.

To date, a sum of £2,297,000 has been expended by the New Zealand Government, irrespective of the heavy interest charges which have accrued since the commencement of operations six years ago; but some extensive works have yet to be completed before the final bill of costs can be prepared, among them being the erection of the power line from Waitaki to Halway Bush, near Dunedin, at an estimated cost of from £80,000 to £100,000, and the reticulation of intervening districts, together with and provision for the delivery of power to the Canterbury centre.

The most important work was the erection of the dam, and the expenditure on this, including the addition of the cut-off wall, as advised by Professor Hornell, amounted to £1,088,580, or 48·2 per cent. of the total outlay. The power-house building, with the large intake attached to it for the handling of the water for the turbines, cost £428 855, or 19 per cent. of the total cost, and to this has to be added an additional sum of £195,078, or 8·7 per cent. of the total, for electrical installations and equipment inside, or attached to, the power-house. This amount, includes the two turbines which are now in operation. When the works are operating at capacity there will be three more turbines, the installation of which will involve, with all the necessary transformers, as much again as has already been spent on the power-house equipment.

The tail race was erected at a cost of £63,835, or 2·9 per cent. of the total, while the establishment, construction, and appointment of the township of Awakino, or Waitaki Hydro, as it is better known, cost no less than £25,400. Land to the value of £20,000 had to be purchased, and, consequent on the flooding of a considerable section of what is known as the old Slip Road, which was the only means of access to two stations on the Canterbury side of the river, road deviations, reconstruction, and bridge building had to be carried out to the tune of £29,360, or 1·3 per cent. of the total cost. This sum includes the cost of the handsome Waitangi Bridge, erected at a cost of £15,000, about 5 miles above the site of the dam, to provide a means of crossing the river. With approximately £380,000 spent on transmission lines to date, and with the cost of the work that is still in progress on and around the dam, the actual total has now reached £2,297,000.

The Waitaki project has given employment to hundreds of men, the numbers during the past six years varying from a minimum of 500 to a maximum of 1250; 45,000 tons of cement, costing £300,000, 4,000,000 superficial feet of timber, and 40,000 tons of other goods have been used in the erection of the dam.

The Port Eglinton Junction Railway Collision.

THE accompanying sketch, which has been prepared from the diagram accompanying the report by Lieut.-Colonel Mount on the fatal collision of September 6th at Port Eglinton Junction, Glasgow, must be read in conjunction with the summary of the report on our leader page. The two trains concerned were (1) a passenger train from St. Enoch, which had travelled thence on the up main line and was crossing, under clear signals, on to the up Canal line to proceed to Kilmarnock, and (2) a passenger train from Paisley on the down Canal line, which should have stopped at signal 73.75. The latter train overran that signal and the two trains met, practically head-on, with the result that six passengers and three of the four enginemen were killed. The driver of the train from Paisley was severely hurt.

Two relevant matters call for mention. The first relates to the block regulations, which, in effect, provide that when the down Canal line is clear "to this box" and the train-out-of-section block signal has been given for the preceding train, the "is-line-clear?" block signal may be acknowledged for a following train. The words "clear to this box" have not been read literally, but the term has been applied as covering the area between the junction home signals in each direction. Under that interpretation the train from Paisley could be accepted from Shields even though the road was set for a crossing movement from up main to up Canal.

The other point is the heavy reverse curvature of the line after leaving Shields-road station and its influence on the sighting of the signals. The curvature is firstly left-handed for 262 yards on radius of 21 chains, followed by tangent for 110 yards and, secondly, right-handed for 258 yards on radius of 12·5 chains. Incidentally, the gradient rises 1 in 200 for 583 yards to the point of collision and thence, past Port Eglinton Junction box, at 1 in 86. We mention this latter point because the driver, after, he said, he had seen the home signal at that box at "clear," had to turn round—his engine was running tender first—to open his regulator and notch up the engine to carry the train up the 1 in 86 into Cumberland-street Station.

We will give the facts as to the running view of the signals in Colonel Mount's own words. Before doing so, however, it is essential to note that at 5.34—the collision

occurred at 5.38 p.m.—the signalmen at Port Eglinton Junction accepted a train from Ardrossan on the down main line and lowered, presumably at the same time, signal 65 for that line. The Paisley train was accepted at 5.32. The reason why we draw attention to No. 65 signal will be appreciated when Colonel Mount's narrative is read. It is as follows :—

"Owing to the above-mentioned curvature, somewhat unusual conditions prevail with regard to the view a driver obtains of signals when approaching the junction from Shields-road Station over the down Canal line. For the purpose of noting these conditions, I travelled on two occasions on the footplate of a similar engine, running tender first. The driver's position is on the right-hand side of the footplate in the direction of travel, viz., on the side on which are located the down homes Nos. 73, 75 and the up starting signals Nos. 46, 48.

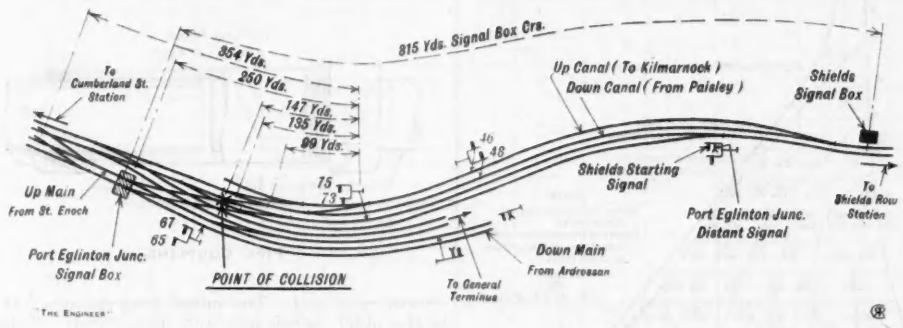
"At a point 33 yards in advance of Shields down starting signal the four signals just named come into view more or less simultaneously with the down main home signals Nos. 65, 67, and, surprisingly, the last named appear on the right, whilst up signals Nos. 46, 48 are in the middle, higher up, and Nos. 73, 75 appear to the left lower down.

"The relevant subsequent changes in the positions of these signals, as seen by the driver while approaching them, are as follows :—At a point 35 yards farther on, viz., 214 yards before reaching up signals Nos. 46, 48, the diamond-shaped plates—required under Rule 55—on the post of these signals passed across the line of vision of Nos. 73, 75 and it was not until after travelling a further 152 yards that these plates, which were so prominently displayed, cleared the line of vision of signals Nos. 73, 75.

"Briefly, the line of vision of signals Nos. 73, 75 was more or less affected while traversing a distance of about 152 yards between points 343 yards and 191 yards before reaching them. Thereafter, the view of these signals is quite uninterrupted, viz., over a distance in rear of them of 191 yards, though, curiously enough, the down main homes Nos. 65, 67, which are 156 yards ahead of Nos. 73, 75, do not assume their true relative position, to the left, until after a point only 62 yards before reaching Nos. 73, 75 is passed.

"Over the distance, therefore, of 316 yards up to this point—62 yards before reaching signals Nos. 73, 75—it is a fact that the view of the signals on the occasion in question, as presented to the driver of the Paisley train, was that, on the right, there was the main line bracket post carrying signals Nos. 65, 67, and, on the left, the nearer bracket post carrying signals Nos. 73, 75, which controlled his movements. When these signals first come into view, I noted some difficulty in realising which post was the nearer of the two, particularly as post Nos. 46, 48 is nearer than both."

Before referring our readers to the comments, on our leader page, on Colonel Mount's report we would emphasise the fact that in his conclusion that officer feels that the driver of the Paisley train, "when they (the Port Eglinton Junction signals) came into view for the first time, with the down main homes on his right, as already described, jumped to the conclusion that No. 65, which was at 'clear,' applied to his movement."



LAY-OUT OF LINES AT PORT EGLINTON

The Faraday Society.

THE Faraday Society will hold a general discussion on "The Structure of Metallic Coatings, Films, and Surfaces," on Friday and Saturday, March 29th and 30th, 1935, at the Imperial College of Science and Technology, South Kensington, S.W.7. The morning sessions commence at 10 a.m. and the afternoons at 2.30 p.m. The laboratories of Professors Thomson and Finch will be open for inspection and demonstration purposes. An introductory paper will be presented by Professor C. H. Desch, after which the following papers will be read :—Part I : "Electron Diffraction Methods" : "An Apparatus for Electron Diffraction at High Voltages," by Professor G. F. Thomson ; "Electron Diffraction and Surface Structure," by Professor G. T. Finch ; "The Problem of Inner Potential in Electron Diffraction," by Professor W. E. Laschkarew ; "Electron Diffraction of the Structure of Condensed Metallic Films and Surfaces," by Professor F. Kirchner ; "The Thickness of the Beilby Layer on Polished Metals," by Mr. H. G. Hopkins ; and a paper by Professor J. J. Trillat. Part II, "The Structure of Metallic Coatings" : "The Crystallisation of Thin Metal Films," by Professor E. N. de C. Andrade ; "The Validity of Drudes' Optical Method of Investigation of Thin Films," by Professor L. Tronstad ; "Optical Research on Evaporated Metal Layers," by Professor L. S. Ornstein ; "The Determination of the Structure of Electrodeposition by Metallurgical Methods," by Mr. D. J. Macnaughton ; "The Influence of the Structure of Electrodeposited Metals on its Chemical and Physical Properties," by Professor M. Schlötter ; "On 'Somatoid' Elements of Structure in Electrolytic Metal Deposits," by Professor V. Kohlschütter ; "The Controlling Influence of Films on the Structure of Electro-chemical Metallic Coatings," by Dr. E. Liebreich ; "Cathodic Films in the Electrolytic Reduction of Aqueous Chromic Acid Solutions," by Dr. E. Müller ; "The Structure and Physical Properties of Nickel Deposited at High Current Densities," by Dr. W. Blum and Dr. C. Kasper ; "Electrode Potentials and the Nature of Electro-deposits," by Dr. S. Glasstone ; "Contribution to the Experimental Study of the Influence of the Support upon the Structure of Electrolytic Deposits," by Professor A. Portevin ; "Influence of the Bas Metal of the Structure of Electro-deposits," by Mr. A. W. Hottersall ; "Differences in the Structure of Electro-deposited Metallic Coatings Shown by X-ray Diffraction," by Mr. W. A. Wood ; "The Structure of Electrolytic Chromium," by Messrs. L. Wright, H. Hirst, and J. Riley ; "Determination of the Phase-structure of Metallic Protective Coatings by Anodic Dissolution," by Professor A. Glazunov ; "Improvement of the Quality of Sprayed Metallic Coatings by the Use of Non-metallic Intermediates and Supports," by Dr. E. Reininger ; "Factors Influencing the Formation and Structure of Hot-dipped Tin Coatings," by Mr. E. J. Daniels. The Imperial College Union will be available for luncheon each day and a Guest Night Dinner will be held on Friday night to entertain distinguished overseas guests. Applications for proofs of the papers and dinner tickets should be made to the Secretary of the Faraday Society, Mr. G. S. W. Marlow, 13, South-square, Gray's Inn, W.C.1.

Propeller Fans for Cooling Electrical Machines.

THE advantages of propeller fans for cooling electrical machinery are discussed in a paper read by Mr. Ralph Poole before the Institution of Electrical Engineers on Thursday, February 14th. Special tests show that a propeller fan designed according to modern aerodynamics is preferable to the paddle-wheel type. The author explains that the windage efficiency of a machine with a fan is far more important than that of the machine alone, and the most efficient fan does not necessarily give the most efficient machine. Great care must be taken in computing from friction and windage tests the actual power taken by the fan, which can be designed to rotate the air more efficiently than the machine itself, so that the increased fan power may be more than balanced by the reduced machine windage. Stress is laid on the need for good inlet conditions for the satisfactory operation of propeller fans. Tests made on a turbo-alternator illustrate the effect of guide vanes in the air intake to propeller fans, and the author points out that both circumferential and radial guide vanes are essential. For cooling large turbo-alternators, two fans in series on a variable load are shown to give greater efficiencies and flexibility than two fans in parallel. High efficiencies are claimed for a special scheme of series propeller fans which simplifies the dampers associated with a turbo-alternator ventilation scheme.

There are limitations set by the general construction of the machine itself, and it is often found that the dimensions of the fan are decided by factors other than the fan output. This is a serious drawback in the design of a centrifugal fan, which is not very flexible in application, but it is found that propeller fans can be arranged to suit most cases, even when the centrifugal fan fails. On the point of efficiency the propeller has a decided advantage, since if the air speed is not too high there is no great difficulty in obtaining an efficiency of 80 per cent. on the static head only, whilst on the total head it is possible to obtain even higher values. The most difficult fan of the propeller class to design is that in which the pitch is low, since a small error in blade angle gives a relatively large error in output and efficiency, the difficulty being increased if the low-pitch fan is required for a relatively high pressure, calling for a large number of blades. The presence of a large number of blades, or a high solidity, increases the rotation in the slip-stream, and therefore introduces a further loss of energy, which can only be recovered by the use of guide vanes or by rotating two series fans in opposite directions.

The propeller fan is most adaptable to the cooling of D.C. machines, since it can be fitted at the end remote from the commutator and made to blow through the machine and across the commutator, keeping out all brush dust. Furthermore, this arrangement does not interfere with the accessibility of the brush gear. To maintain accessibility a centrifugal fan would have to be fitted at the rear end of the machine. Its diameter would therefore have to be reduced sufficiently to allow the air to turn axially into the machine. Such a scheme gives poor armature ventilation, in addition to lengthening the machine. Salient-pole motors and alternators are ideal cases for the application of propeller fans. The rotor has propellers taking in air at each end and discharging into the spaces between the poles, and then out through the vent spaces in the stator.

Pipe ventilation becomes simple when propeller fans are adopted, as there is no longer any need for a volute or whirling chamber. Furthermore, reversibility is no longer a problem, since propeller fans can be designed to operate efficiently in both directions ; but it will be realised that the air flow will be reversed. This may prove a disadvantage in certain cases of pipe ventilation.

It is not generally realised, the author explains, that input tests with fan and with fan removed do not give the true power taken by the fan. The energy taken up in rotating the air passing through the rotor is supplied as torque, apart from that required to drive the fan. Thus when the fan is removed there is a reduction in the windage of the rotor. On the other hand, an increase in the amount of air delivered by the fan also results in an increase in the power taken to rotate the air passing through the rotor. The difference in the friction and windage readings for two fan outputs will, therefore, not give the true change in the power taken by the fan. Friction and windage tests will, of course, give reliable results when the amount of air passing through the rotor is very small.

The author has shown in a paper read before the Institution of Civil Engineers that it is possible to design propeller fans so that when the second stage of a series system is closed down it will act as guide vanes to the first stage. Thus not only is the efficiency of the double stage higher than that of a single fan, but with one closed down the efficiency is higher than that of a fan alone. It is obvious that such a system is very adaptable to the cooling of large turbo-alternators, giving high efficiency together with a simplified damper system. Furthermore, it is only necessary to design each propeller of a series system for half the pressure that would be required in the corresponding parallel scheme. This results in a reduction in the leakage across the fan, with a corresponding increase in efficiency. The cost may also be reduced, since the peripheral speed need not be so high, as in general the outer diameter of a propeller fan is fixed by the pressure rather than by the air quantity required.

Experience shows that propeller fans can be designed to suit almost all machines ; the deciding feature is ultimately cost. For high pressures it is essential that the radial tip clearance shall be small in the case of a propeller fan, but this requirement increases the cost considerably. The final decision, therefore, rests between cost and efficiency, and is a matter for the customer rather than the manufacturer. It has been found that in certain cases the propeller fan is quieter than the centrifugal fan, but in general the former requires more careful design to prevent noise. Special attention is being paid to this problem, and much useful information has been obtained from recent experimental work, the results of which may shortly be published.

Although the propeller fan is most suitable for cooling transformers, no reference is made to this problem in the present paper. It is possible that in the near future the question of transformer cooling will be dealt with as a separate subject, *i.e.*, since the type of fan, high-pressure or low-pressure, may determine the arrangement of cooling tubes. While forced ventilation may become economical, this is a matter for further investigation by transformer designers.

G.W.R. CARRIAGE MARSHALLING YARD.

A BIG scheme to facilitate the formation of passenger trains is being carried out by the Great Western Railway at Old Oak Common, the engine and carriage depôt for Paddington Station, which is already the largest in the country and, together with the adjacent locomotive depôt, covers an area of more than 100 acres.

The depôt handles some 2000 passenger coaches daily, empty stock from incoming expresses being re-formed to provide the outgoing trains from Paddington. The time allowed for this is sometimes as short as two and a-half hours, during which the coaches have to make a three-mile journey each way, be examined, cleaned, equipped, stocked, and re-formed into their outgoing order. Considerable shunting operations, therefore, are involved, and an average of five cuts is made to every empty stock train arriving at the depôt. At present there are some ten and a-half miles of sidings, including five roads for the reception of empty trains. Not more than nine to twelve coaches can be accommodated in each of these roads, whereas many of the longer trains to-day comprise fourteen to seventeen coaches. An added disadvantage is that the incoming and outgoing lines cross each other at both the east and the west ends of the yard.

The new scheme involves the relaying of 7 miles of sidings and the construction of 3½ miles of new sidings. There will be seven reception roads, each of twenty coaches capacity. Separate in and out lines to and from Paddington at both the east and the west ends of the yard will be provided, and, in addition, the twenty 1000ft. long sidings in the covered carriage shed are to be rearranged to simplify shunting. This shed will be equipped with a plant for charging train lighting batteries. Steam heating arrangements are to be extended so that trains can be heated simultaneously.

An automatic telephone exchange with seventy stations is to be installed, so that shunters will be able to communicate with each other, the depôt, and any of the seven signal-boxes, or receive instructions without crossing the railway lines. Water columns are to be erected where engines can take water without stopping their shunting work. A 70ft. turntable is to replace the existing one of 50ft., and this will permit the largest locomotives or rolling stock used by the company being turned in the depôt.

THE Minister of Transport has appointed Captain R. S. D. Stuart to be Chief Examiner in the organisation which is being set up to examine applicants for motor driving licenses as to their competence to drive, and Squadron Leader A. R. Mackenzie to be the Supervising Examiner for the Metropolitan and South-Eastern Areas. The selections for the appointments of Supervising Examiners for the other areas have also been made, and Selection Boards are now interviewing those candidates selected for consideration for the ordinary Driving Examiner posts.

Progress on the Boulder Dam.

No. III.

(*Continued from page 172, February 15th.*)

Cooling Operations.

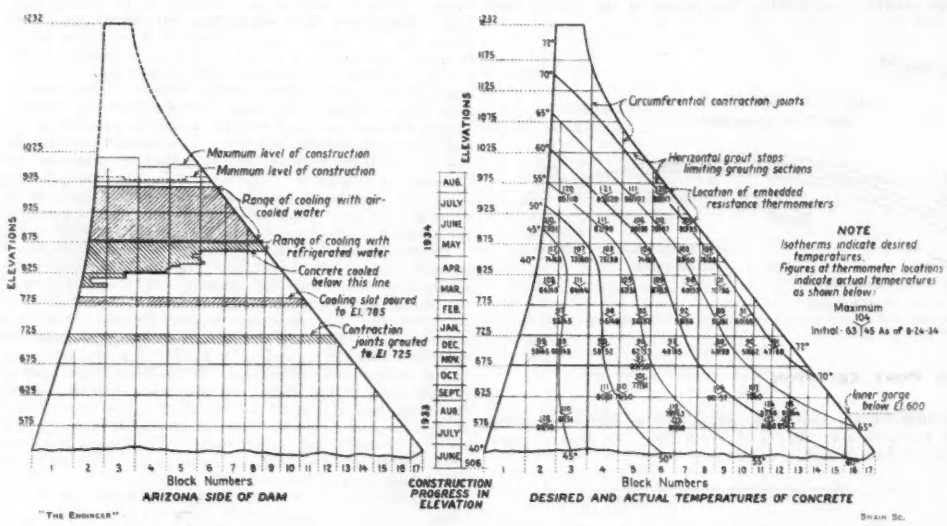
As is generally known, masses of concrete undergo volumetric changes after pouring. The heat of hydration developed during the hardening process causes expansion, and shrinkage follows as the concrete cools at a much slower rate. These opposite movements induce cracks at unlooked-for points and of varying sizes. The Boulder Dam, if poured as a monolith, would take generations to cool, and during that time there would be no way to safeguard the structure against fractures of more or less serious and even hazardous proportions. Therefore, artificial cooling and columnar pouring were resorted to to bring about rapidly any structural volumetric changes, and to end them within a period of months. The radial and circumferential shrinkage joints accommodate movements of the mass due to volumetric change and permit the sealing of the joints with grout when alteration of shape in the columns has ceased.

It should be kept in mind that the heat to be dealt with in cooling the concrete mass is not alone due to hydration, but is in part the result of the heat stored in the aggregates at the time when the concrete was mixed and poured, and the season affects both sources of heat. The measure of heat that has been extracted at any point in the dam, and so far recorded, is shown by the isotherms of an accompanying graph. The same drawing indicates the desired range in temperatures between the two faces of the structure, and those figures are the outcome of intensive laboratory research. Those studies revealed that the water in the reservoir lying below El. 900—that is, the intake penstocks—will have a temperature approximating that of water at its maximum density, while the concrete near the downstream face, as well as the rock of the canyon walls, will have a temperature of something like 72 deg. Fah., which is the mean annual temperature of the air in the locality.

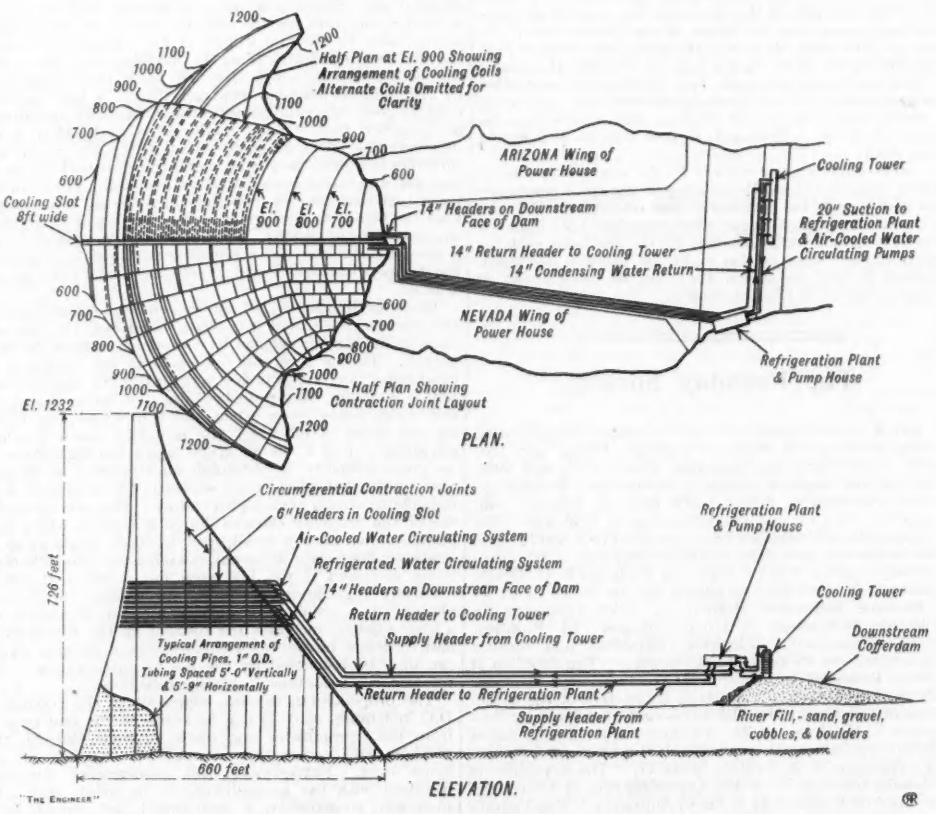
The cooling coils, which extend from each side of the 8ft. central slot to the corresponding abutment limits of the dam, are made up of No. 14 gauge 1in. outside diameter pipes which are buried successively in each lift of concrete—see accompanying plan and elevation—and held in place during the pouring of a succeeding lift, by wire loops anchored to the supporting lift. The cooling pipes are spaced on 5ft. centres vertically and 5ft. 9in. centres horizontally. Each coil at its outmost end makes a 180 deg. bend, and then returns to the 8ft. cooling slot, where it connects with the return header of the system. The coils range in length from 220ft. to 1340ft., and the average length in 5880 coils is 513ft. Every section of the piping, not only within the blocks, but at contraction joints, has plain ends that permit making connections by means of a type of coupling evolved especially for the service. A sketch is reproduced of the coupling. At contraction joints the coupling acts as an expansion coupling, and permits the tubing to move within the nipple without leakage, as the joint opens as a consequence of shrinkage in the concrete. The maximum combined length of piping carrying cooling water in any month was 626,000 linear feet, and the total length of all cooling pipe is 3,017,870 linear feet, that is, 571 miles.

The first of the mass concrete in the dam was poured early in June, 1933. Air-cooled water was admitted to the coils on August 8th following, and refrigerated water was circulated through the coils for the first time on October 11th. Application of the cooling and the refrigerating water is controlled in accordance with the changing temperatures of the mass concrete, which are ascertained with the aid of two types of resistance thermometers. One type of thermometer is embedded in the concrete between the cooling pipes, while the other type is inserted in the end of the pipes at the central slot. In the case of the latter thermometers, it is necessary to halt the circulation in a coil to permit the temperature in the concrete enveloping a pipe to equalise before the special resistance thermometer is put in the pipe. The temperature so ascertained is obtained at a point varying from 25ft. to 30ft. from the face of the 8ft. axial cooling slot. The average temperature difference between the air-cooled water on entering and on leaving the concrete is 7·3 deg. Fah., and the variation ranges between 4 deg. and 12 deg. Fah. In the case of the refrigerated water, the average temperature difference is 11·1 deg. Fah. between the water entering and leaving the concrete, with a variation of from 6·5 deg. to 18·3 deg. Fah. The average rate of flow in each cooling coil is something more than 4 gallons per minute, although the system was designed for a circulating rate of less than 3 gallons per minute. The variations are from 1·9 to 6·6 gallons per minute for the air-cooled water, and from 4 to 5·5 gallons per minute for refrigerated water. According to the estimates of the engineers of the Bureau of Reclamation, the cooling of the mass concrete of Boulder Dam will require the extraction of about 170,000 million B.Th.U. Up to September 1st, 1934, air-cooled water extracted 48,000 millions of these units and refrigerated water has removed 71,000 millions of them. It is expected that the cooling of the dam will have been completed in advance of hot weather of 1935, and within the same interval the last of the contraction joints will have been grouted.*

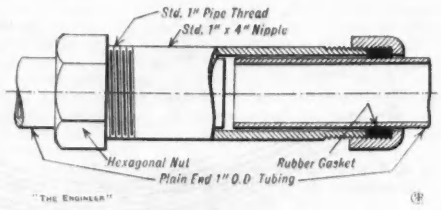
From resistance thermometers embedded in the mass concrete of the dam have been obtained data used in plotting three typical temperature curves, showing changes over indicated time intervals. These curves apply to three different cements used in the concrete. No. 1 is for normal cement, which was used only for a short while in the early construction stage of the dam; No. 2 was a blend composed of 40 per cent. normal and 60 per cent. low-heat cements; while in No. 3 only low-heat cement was used. The initial temperatures, taken in the order mentioned, were respectively 89 deg., 58 deg., and 60 deg. Fah.; the maximum temperatures, in the same sequence, were 131 deg., 97 deg., and 92·5 deg. Fah.; and the rises in temperature were respectively 42 deg., 39 deg., and 32·5 deg. Fah. The temperature rises ascertained up to September, 1934, for normal, blended, and low-heat cement concretes were 41 deg., 38 deg., and 32 deg. Fah. respectively; and those figures were an average for 41, 96, and 150 resistance thermometers located at different positions in the concrete. Specimens of mass concrete that were tested for twenty-eight days in adiabatic calorimeters gave temperature rises for the foregoing cements of 64 deg., 53 deg., and 46 deg. Fah. respectively. There is no loss of heat from a specimen under adiabatic conditions of curing, and therefore the only increase in heat is that due to chemical action during hydration. Accordingly, a comparison of field and of calorimeter temperatures has indicated that the loss of heat from each lift of concrete during the interval between pours—that is, an average of 4·7 days—has been about 33⅓ per cent. of the total heat generated. As pointed out by Byram W. Steele, of the Bureau of Reclamation, these differences in temperature indicate the differences in volume-change characteristics of the three kinds



PROGRESS CHART TO SEPTEMBER 1ST, 1934, AND ISOTHERMS


Half Plan at El. 900 Showing Arrangement of Cooling Coils Alternate Coils Omitted for Clarity
ARIZONA Wing of Power House
Cooling Tower
Cooling Slot 8ft wide
El. 900
El. 800
El. 700
14" Headers on Downstream Face of Dam
20" Suction to Refrigeration Plant & Air-Cooled Water Circulating Pumps
14" Return Header to Cooling Tower
14" Condensing Water Return
NEVADA Wing of Power House
Refrigeration Plant & Pump House
Half Plan Showing Contraction Joint Layout
El. 1232
PLAN.
Circumferential Contraction Joints
6" Headers in Cooling Slot
Air-Cooled Water Circulating System
Refrigerated Water Circulating System
14" Headers on Downstream Face of Dam
Return Header to Cooling Tower
Supply Header from Cooling Tower
Typical Arrangement of Cooling Pipes, 1" O.D. Tubing Spaced 5'-0" Vertically & 5'-9" Horizontally
Return Header to Refrigeration Plant
Supply Header from Refrigeration Plant
River Fill,- sand, gravel, cobbles, & boulders
796 feet
660 feet
ELEVATION.
"THE ENGINEER"

PLAN AND ELEVATION OF DAM SHOWING COOLING COILS

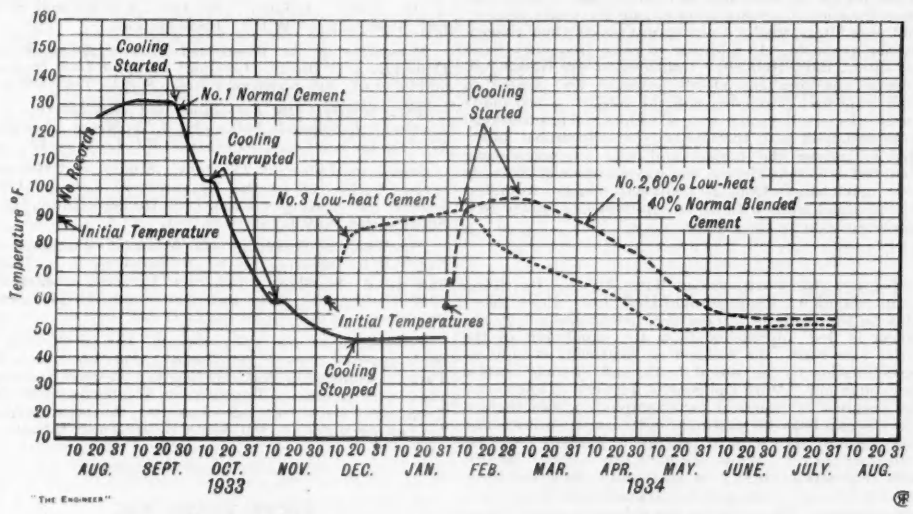


PIPE COUPLING

* These dates have been greatly anticipated.—ED. THE E.

of cement, and afford a rough measure of the value of low-heat cement from the standpoint of promoting economy in the cooling operations. Mr. Steele is responsible for the following information concerning the procedure adopted in grouting the contraction joint system of the dam.

The value of the cooling and shrinking of the mass concrete is largely lost unless care is taken to fill the contraction joint openings with grout of satisfactory density. To obtain the full benefits of controlled cooling in the subsequent grouting, a system of pipes—see perspective drawing—with outlets in the contraction joints at intervals of 30 to

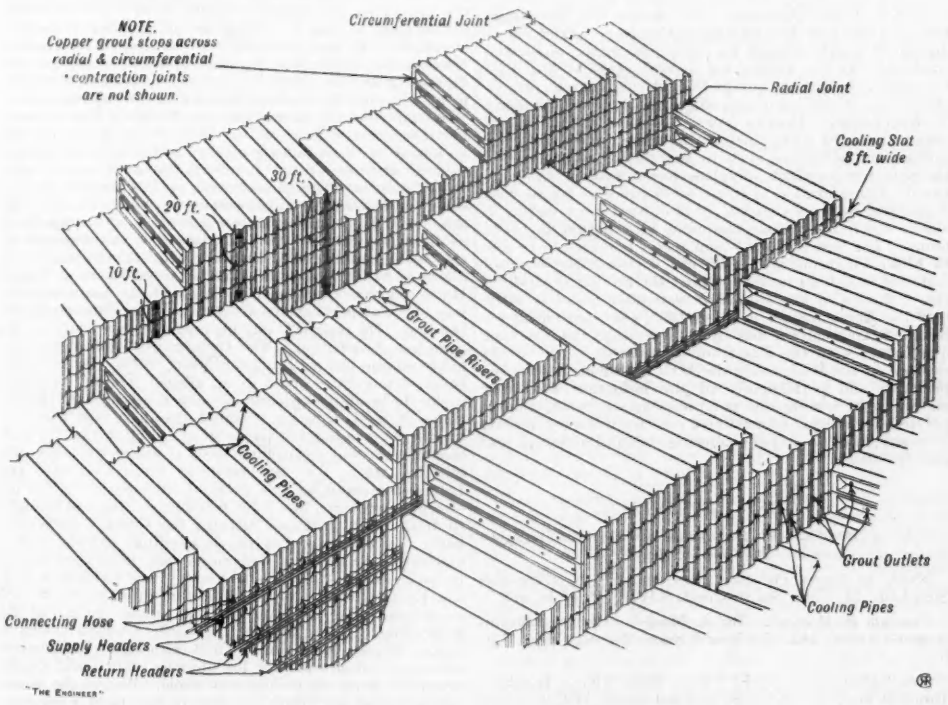


TYPICAL TEMPERATURE CURVES WITH VARIOUS CEMENTS

50 square feet of the mass, is embedded in the concrete adjacent to a joint. These outlet pipes are connected to headers which run to grouting galleries in the body of the dam, and also to both faces of the dam; and in this way a circulating system for the complete distribution of grout, as well as for drawing off water and thin grout not desirable to leave in the joints, is provided. A radial joint in the lower part of the dam is divided, to facilitate filling the joint, into two parts by a vertical grout stop near the centre of the dam. The circumferential joints in a radial tier of blocks are connected, with the exception of the joint which tapers out on the downstream face, to a single header. This exceptional joint is served by an individual header, and is grouted separately.

As the concrete is cooled and the cooling slot is progressively filled with concrete, the grouting of contraction joints is done in 50ft. lifts. For the lower part of the dam, grout was mixed in a seven-sack concrete mixer, which was set up in a gallery at El. 705, on the Arizona side of the dam. The grout, on leaving the mixer, was delivered into an agitator after passing through a screen. The agitator is a vertical open-top tank, 2ft. deep and 3ft. in diameter, equipped with an air-driven motor on a vertical shaft that is fitted with two blades set close to the bottom of the tank. From the agitator the grout flowed by gravity through a 2in. pipe line to the lower galleries, from which the grouting for the first two 50ft. lifts was done. A similar agitator and a duplex piston displacement pump are placed in the lower galleries. The grouting plants will be shifted as the dam rises and conditions change. When the structure approaches the crest line, the grouting outfits will be mounted on platforms erected for the purpose on the downstream face, or they will be located directly on the crest where most convenient.

The radial contraction joints in each lift are grouted first, and then, after an interval of from seven to ten days, the circumferential joints in the same lift are grouted. The primary filling of a joint or set of joints is by gravity flow from the last agitator, and the pump is brought into action only when a joint is nearly full, and is employed then to drive off excess water and thin grout, and to consolidate the film of grout in a joint. A pressure of 100 lb. per square inch has generally answered for this purpose, but pressures up to 300 lb. per square inch have been resorted to where conditions made it necessary to do so to obtain a grout film of satisfactory density. In general, one sack of cement has been used for about 100 square feet of contraction joint area, and the water-cement ratio of the grout has ranged from 0·75 to 1·00.



CONTRACTION JOINT LAY-OUT

Assuming that the cement, which has been passed through a 200-mesh screen to facilitate the penetration of fine seams, is 50 per cent. voids and carries 50 per cent., more or less, of mixing water, and the remainder has been driven into the concrete flanking a joint, the results indicate that the contraction joints will average in width from 0·10in. to 0·12in. The width of the joints is influenced by temperature variations between the two faces of the dam and by the measure of heat extracted. From the vantage point of any of the galleries within the dam, it is possible to see how remarkably uniform are the contraction joint openings, and to note at the same time the absence of other fissures that usually accompany volume changes of the magnitude of those produced deliberately in the case of Boulder Dam by the controlled cooling operations.

Radial and circumferential joints are separated generally by copper grout stops placed across circumferential joints near their junction with radial joints, and the stops are anchored in the concrete on each side. In addition to the foregoing vertical grout stops, there are also horizontal grout stops placed in every joint at 50ft. intervals. The arrangement is such that horizontal grout stops are interposed in both radial and circumferential spaces of varying dimensions, so as to subdivide those interstices into 50ft. lifts. At the upper face of the dam there is a Monel metal water stop at each radial joint, and there are also stops of the same description at the downstream ends of radial joints below El. 675, where copper stops would corrode if exposed to tail-race water. Copper stops are brazed with torches, while the Monel metal stops are electrically welded. After being thus fabricated to ensure effective sealing, the stops are coated with an asphaltic emulsion. This treatment serves to ensure against leakage and yet prevents too tight a bond with the concrete, and thus permits slight slippage when a joint widens, owing to the shrinkage of the concrete blocks flanking the channel.

The Government specifications called for the painting of the contact surfaces of the blocks at joints; but subsequent experiments indicated that the unpainted blocks would separate after pouring, and so provide clean flanking surfaces between which the grout would flow freely. Since then painting of contraction joints has been discontinued. The circumferential joints are shaped so that the resultant inclined pressures in the dam are normal or parallel to the contact faces of a joint, and this tends to minimise shearing stresses on the grout film in a joint.

A number of springs were opened up during the excavating for the dam foundation, and pipes were inserted in the crevices and the remainder of each fissure was closed with lead. The various pipes were grouped to manifolds, and from the latter the water was conveyed either to the 8ft. cooling slot or to the nearer face of the dam. While the earlier pours of the dam were being made, as much as 20,000 linear feet of small pipe was used to carry off water from the springs. Subsequently, grouting and drainage holes, drilled along the axis of the dam, effectually arrested or led the water outside the dam, so that it would not do any harm to that structure.

(To be continued.)

Literature.

The Spirit of Chemistry. By ALEXANDER FINDLAY, Professor of Chemistry, University of Aberdeen. Second edition. London: Longmans, Green and Co. 1934. Price 10s. 6d.

WE reviewed the first edition of this excellent book in October, 1930; a year later a new impression was called for, and now—we are glad to observe—a revised edition has appeared. The revision consists in additions made necessary by recent discoveries—"heavy water," for example—but leaves the spirit of the work, as we may call it, unchanged.

The ordinary text book has less spirit than a turnip. It is designed with the sole purpose of filling students with sufficient facts to enable them to pass examinations. It does not consider for a single instant the ultimate good of knowledge. Professor Findlay's volume is written with a different purpose. He believes that science has a cultural value, and here he endeavours, with no little success, to present an historical and technical picture of the progress of chemistry in such a manner that it may augment the intelligence of the reader. That, we need hardly say, is a very different thing from increasing his knowledge. A knowledge of chemistry may make a man richer in the things subject to income tax, but it will not make him intellectually any richer unless he is enabled through it to take a broader view of the whole domain of knowledge. "The collecting of facts is only the first step in the advance of science," says Professor Findlay, "for science is not a mere collection of facts, but the satisfaction of an intellectual desire; not a mere gathering of stones along the pathway of life, but the building of these stones into an edifice."

But whilst the purpose of the work is to promote and encourage a wide view of the science of chemistry, it cannot be described as a "popular" work. We should like to think that it could be read and enjoyed by the tinker and the tailor and the candlestick maker, but fear that, in fact, it is rather beyond the ordinary general reader. Yet it is not the least bit beyond anyone who has had the scientific training of an engineer, and to such men it may be very safely commended. For here they will find not only the science of chemistry developed historically—the soundest and most profitable way—but they will find the broad facts and laws as they have been ascertained up to the present time set forth briefly and in a fairly simple readable form. We might commend it also to students of chemistry itself in the hope that by widening their view it might do something to counteract the ill effect of specialisation.

A little knowledge is a dangerous thing only when

it is used indiscreetly. In any case, it is far better than no knowledge at all, if it be used to broaden the outlook of a generation which is being forced by circumstance to concentrate too much on single subjects.

This Modern World and the Engineer. Royal Scottish Society of Arts, Edinburgh. 1934. Price 5s.

THE annual programme of the Royal Scottish Society of Arts includes a series of six addresses known as the Keith Lectures. In 1933 the series was arranged as a symposium on "The Trend of Modern Engineering," and five of the speakers were Edinburgh professors, whilst the sixth was Dr. R. Lessing, F.I.C., whose subject was "Chemical Engineering." In this volume the six lectures are presented, and, in a final essay, Professor Henry Briggs, President of the Society, and Hood Professor of Mining in the University of Edinburgh, sums up the position as seen by him.

We stress the last words—"as seen by him"—for it seems scarcely probable that many technical readers of the preceding discourses will take the same rather reactive view that he does. Professor Briggs appears to be amongst those who regard "technocracy" as the villain of the present industrial drama. "We may be inclined to doubt," he writes, "whether progress has any real connection with the advance of applied science; we may deplore the only-too-obvious fact that the rising tide of mechanisation, of machine-made systems, and machine-like organisation is cutting off millions from the labour market, but for us there is no choice of ways and no turning back. The only civilisation we know rests on a mechanical foundation; it would collapse without power and the appliances that depend upon power. We have got to go on, but with our eyes open (may we hope) to a wider panorama of consequences, holding fast to the conviction that in this sombre and menacing hegemony of the machine we are witnessing a perversion of purpose; that the products of man's skill and courage were intended to bless and not to curse, to give release from drudgery and not to crush and impoverish—to serve, not to master." This passage represents, we think with considerable accuracy, the opinions of the author. If it shows that he recognises the impossibility of adopting an Erewhonian policy, it exhibits also an acceptance of the popular belief that the machine and technical progress are the primary causes of unemployment. It is, we suggest, high time that a carefully weighed and authoritative report upon that thesis should be issued. The whole position should be examined by a Commission with the help of evidence from all industries. We believe that such an inquiry would result in the complete vindication of technological progress against the charge that it provokes unemployment. We believe also that it could be shown that no single industry which has adopted the latest advances in methods of production has failed to increase greatly the total number of people employed. If we are wrong, it is desirable that our error should be driven home by chapter and verse. If we are right, then the circulation of such opinions as those to which Professor Briggs has given his endorsement should be stopped. They cannot fail to engender dislike of the machine and of everything that spells progress amongst workpeople and the investing public, and may do much harm by hindering our power to meet world competition. Professor Briggs recognises that nothing but international agreement could arrest these developments. But we say without hesitation that the difficulties of securing international agreement in the limitation of armaments would be mere child's play by contrast with the difficulties presented by attempts to effect the "limitation of progress." It is not within the bounds of possibility. The wisest, indeed the only, course is to push on with "progress," but so to direct it that its age-old tendency to increase the total demand for products, and hence the total amount of employment, is encouraged.

About the six lectures themselves we need not say much. They are of unequal merit, but taken in the lump they do give the reader a very fair idea of the trend of modern engineering—widely considered—at the present time. That they were addressed to general, not expert, audiences adds to their value, even to the engineer. The lecturers took broad views of their subjects and avoided highly technical points which often mar "visibility." In a mist, imagination and intuition may be better guides than searchlights. Great thinkers are often able to sense the future long before it is possible to see anything of it clearly. These lecturers have not painted every brick in the great edifice they have portrayed, and by prudent omission and condensation have given a better picture of the conditions that exist and a better vision of the developments which the future may hold, than if they had been over careful about small things.

SHORT NOTICES.

Electric Circuits and Wave Filters. By A. T. Stark. London: Sir Isaac Pitman and Sons, Ltd. Price 21s.—Although this book will appeal mainly to electrical communication engineers, including, of course, those associated with wireless work, it also meets requirements of those studying problems connected with power transmission and distribution, dielectric theory, and the design of electrical machinery. The author contends that possibly because the major developments in electrical communication have been imported from America and Germany, until recently the theory of electric circuits has been neglected in this country. The book is therefore believed to meet a need which will be felt still more in the early future. A brief and relevant treatment of electromagnetism proceeds a thorough discussion of the vector and symbolic methods used in A.C. work. The design of resistances, condensers, and coils, including transformers, is then considered in considerable detail, and the theory of the combination of them follows. By incorporating methods well established for the treatment of power transmission the theory of the four terminal network is clarified. Wave filters are discussed mainly on the basis of the fruitful methods of treatment adopted by Dr. O. J. Zobel, of the Bell telephone laboratories. A more general and orderly approach to the general problem of the wave filter, which led the author to a method of filter design, is described. A new notation impresses order among the many types of band pass filters, whilst a nomogram makes their characteristics available. In addition to radio frequency band pass filters, radio frequency transformers are considered. Acoustic analogies and electro-acoustics are treated in detail from first principles, and the subject of transients in networks includes some original results and implications. Those equipped with the necessary mathematical knowledge to master the subject and who are particularly interested in electric circuits and wave filters will probably derive much benefit from the book, which begins from first principles and leads without any omission of theory to a complete survey of the subject.

Theory of Alternating-current Wave Forms. By Philip Kemp. London: Chapman and Hall, Ltd. Price 15s.—While in the study of alternating-current technology the subject is first approached from the standpoint of the simple sine wave, the method of treatment is only an approximation to the actual truth, and in some cases a very rough one. With the general advance of knowledge and progress in practical oscillography, it was realised that the gap between sinusoidal alternating currents and those actually met with in practice is in many cases far from insignificant. While designers have solved the problem of generating e.m.f. of practically sinusoidal form, circuit conditions often give rise to much distortion, which is undesirable. The object of the volume is to put before readers with a general knowledge of alternating-current theory, those facts relating to non-sinusoidal waves which are necessary for a proper understanding of the subject. Two chapters on the properties of complex waves are followed by others on the effect of iron, the effects of other conditions, harmonics in polyphase systems, and harmonic analysis. The subject is treated generally without reference to specific machines or types of apparatus which the author hopes to consider in a later volume. Needless to say, the book is not likely to appeal to those with little or no knowledge of mathematics, but others who have familiarised themselves with alternating-current theory in general and have mastered the mathematics involved, will probably find much in the volume to interest them. So far as we know, it is the only book devoted exclusively to alternating-current wave forms.

Electric Power Metering. By Archer E. Knowlton. London: McGraw-Hill Publishing Company. Price 24s.—Advanced short courses for electrical meter engineers, conducted by the author for several years at the Yale University, led to the production of this volume, which, although of American origin, will probably appeal to many in this country. Besides power metering instruments of various kinds, it covers instrument transformers and their calibration, polyphase systems and vector relations, and the principles on which polyphase power measurements are based. Consideration of house service meters begins with a chapter on the evolution of the watt-hour meter, in which much interesting historical information is to be found. The first real watt-hour meter is shown to be due to Elihu Thomson, who took out a patent for a motor meter of that kind in 1889, whilst the last great stride in the evolution of the induction watt-hour meter is attributed to Shallenberger, who, in 1895, patented means for bringing the resultant flux from the voltage coil into time quadrature with the flux from the current coils. Other sections of the book cover the D.C. watt-hour meter, the principle and performance of the induction watt-hour meter, meter testing, the polyphase meter, verification of polyphase metering connections, reactive metering, and its accuracy, kilovolt-ampère metering, demand metering, and load totalising.

BOOKS RECEIVED.

City of Birmingham Handbook, 1935. Birmingham: Information Bureau, The Council House.

Safety in Spray Painting. London: P. S. King and Son, Ltd., 14, Great Smith-street, S.W.1. Price 4s. net.

Cements et Mortiers. By A. Maché. Paris: Libraire Armand Colin, 103, Boulevard Saint-Michel. Price 12f. net.

The "Mechanical World" Year Book, 1935. London: Emmott and Co., Ltd., 28, Bedford-street, W.C.2. Price 1s. 6d. net.

Diesel Engine Design. By H. F. Shepherd. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 17s. 6d. net.

Are Trade Unions Obstructive: An Impartial Inquiry. London: Victor Gollancz, Ltd., 14, Henrietta-street, W.C. Price 5s. net.

Belt Conveyors. By H. Davies. London: The Draughtsman Publishing Company, Ltd., 96, St. George's-square, S.W.1. Price 4s. net.

Calvert's Mechanics' Almanack for 1935. Edited by Wm. Endsor. Manchester: Wm. Endsor and Co., 5, Bridge-street. Price 6d. net.

Piles and Pile Driving. By A. C. Dean, M.C., M.Sc. London: Crosby Lockwood and Son, Ltd., Stationers' Hall-court, E.C.4. Price 42s. net.

Specification, 1935. Edited by F. R. S. Yorke. London: The Architectural Press, Ltd., 9, Queen Anne's-gate, S.W.1. Price 10s. 6d. net.

The Mining Year Book, 1935. Compiled by W. E. Skinner. London: W. E. Skinner, 15, Dowgate-hill, E.C.4. Price 21s. 6d. net.

Report on Gravity Retaining Walls. London: The Institution of Structural Engineers, 10, Upper Belgrave-street, S.W.1. Price 1s. 6d. net.

Marketing Industrial Equipment. By B. Lester. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 21s. net.

Metallurgy: An Elementary Text-book. By E. L. Rhead. London: Longmans Green and Co., Ltd., 39, Paternoster-row, E.C.4. Price 10s. 6d. net.

Automobile and Aircraft Engines. Third edition. By A. W. Judge. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 42s. net.

Motorships of the World and Motorshipping Record. Edited by A. C. Hardy. London: Sampson Low, Marston and Co., Ltd., 100, Southwark-street, S.E.1. Price 10s. net.

Water Power: Its Estimation and Development, with Particular Reference to India. By J. W. Mears. London: W. Thacker and Co., 2, Creed-lane, E.C.4. Price 12s. net.

Studies on Industrial Relations. Studies and Reports, Series A, No. 38 of the International Labour Office. London: P. S. King and Son, Ltd., Orchard House, Great Smith-street, S.W.1. Price 6s. net.

Hutchinson's Technical and Scientific Encyclopædia. Vol. I, A to Direction Finding. Edited by C. F. Tweny and I. P. Shirshov. London: Hutchinson and Co. (Publishers), Ltd., 34, Paternoster-row, E.C.4. Price, 28s. net (set of three volumes, £4 4s. net.).

Proceedings of the Thirty-seventh Annual Meeting of the American Society for Testing Materials. Vol. 34. Part I: Committee Reports, New and Revised Tentative Standards, Tentative Revisions of Standards. Part II: Technical Papers. Philadelphia, Pa.: American Society for Testing Materials, 260, South Broad-street, U.S.A.

SIXTY YEARS AGO.

THE perils of periphrasis have never been brought more clearly before us than by the accounts of the Ofenheim trial in Vienna which we published in our issues of February 19th and March 5th 1875. A necessity for circumlocution may have been forced upon our special correspondent, for the case involved not only Victor Ofenheim, Knight of the Black Sea, but also many members of the Austrian nobility, high Government officials and Ministers of the Crown and even the Emperor himself. In addition, it is more than hinted that certain Englishmen as individuals or in association with Anglo-Austrian undertakings were concerned in the proceedings which led to the trial. The necessity for cautious expression need not, however, have led our correspondent into flights of rhetoric which make it difficult for a later generation to follow the ramified details of the case. He says enough to whet the appetite of a scandalmonger, enough, perhaps, to inspire the pen of an imaginative scenario writer, but certainly not enough to satisfy the needs of a sober historian. Ofenheim was born in 1820. In his youth he studied Eastern languages and the law and later entered the diplomatic service. At the age of 31 he joined the Government office for the general direction of railways and three years later he was at the Austrian Board of Trade framing laws for the granting of concessions. Subsequently he joined the Karl-Ludwig railway and in 1864 he became general director of the Lemberg Czernowitzer railway. In addition he allied himself with no less than ninety-six other undertakings, of seventeen of which he was the director. From these various activities he accumulated an immense fortune. In 1872, however, the first sign of the coming storm was revealed. In some manner not disclosed he fell foul of the Minister of the Board of Trade. He would have to resign his office with the Lemberg railway, he was told, or the Government would sequestrate the line. He resigned, but his enemies were bent on his complete destruction. The Government was eventually led to charge him with appropriating to his own use large sums of money received in an alleged wrongful manner under the heading of preliminary expenses, through the purchase of land, through irregular dealings with the contractor, by evading the payment of stamp duties, by purchasing material and rolling stock of inferior quality and in other ways. On ten counts in connection with the Lemberg railway he was charged with receiving for his own use something like 1,500,000 florins. He was brought to trial. For thirty-six sittings the Court debated his guilt. In the course of the proceedings exposure after exposure was made of dishonesty and unscrupulousness in many places. The whole country was shocked and in the Exchanges of Europe, Austrian enterprises suffered an eclipse. We can give only the merest outline of the proceedings. They were of the stuff of which drama is made. We see Ofenheim cool and calm before his accusers attracting admiration for his obvious ability and finally sympathy from the people as a whole. We see the prosecution forced to withdraw some of the most important counts in the indictment and the counsel for the defence cleverly embroiling the Minister of Commerce in charges no less criminal than those brought against his client. We catch a glimpse of that Minister feverishly searching for a certain lost receipt, to destroy it, implies the defending counsel, to refresh his memory, says he. We hear a rumour of interference with the course of the trial on the part of some one in high office and of the presiding judge's sudden illness and collapse during his summing up. For over a month the trial, just as it was reaching its close, was suspended to await the judge's recovery. Then came the verdict. Not guilty on every count, said the jury, and the judge, in the name of the Emperor, declared Victor Ofenheim innocent of the accusations of fraud brought against him. Just before the trial ended the Minister of Commerce obtained from the Emperor leave of absence for two months to recruit his health. . . . Periphrasis, in this instance, seems to have deprived us of the details of as nice a piece of plotting as ever flicked across a screen.

Rail and Road.

THE Great Western Company's streamlined oil railcar, running on a local service from Southall, completed the first year's service on February 4th. During the twelve months it had covered 60,000 miles and had carried 136,000 passengers.

THE report by Colonel Mount on the collision of September 6th between two passenger trains at Port Eglinton Junction, whereby six passengers and three of the four enginemen were killed, was issued on February 14th, and is reviewed elsewhere in this issue.

IN order to allow for the running of heavier and more powerful locomotives on the Blaenau Festiniog branch, the Great Western Company is about to renew thirty-four bridges in the 16 miles between the junction with the main line at Bala and Trawsfynydd.

ANSWERING a question addressed to him on February 13th, the Minister of Transport said that he was prepared to give favourable consideration to any application from local authorities for the experimental extension of the silent zones in their own areas to the whole of the twenty-four hours.

THE report of the Southern Railway Company has a reference to the new railway—sanctioned in 1930—from Motspur Park on the Wimbledon–Epsom branch to Leatherhead on the Portsmouth main line. It is announced that the railway for the 4½ miles up to Church-lane, Chessington, is to be begun shortly. It is to be equipped for electric traction and will have stations at or near Old Malden, Tolworth, Moor-lane (Chessington), and Garrison-lane (Chessington).

THE annual report of the Great Western Railway Company contains two items of general interest. One is that the Standing Joint Committee, set up under the London Passenger Transport Act, 1933, has prepared a scheme for the pooling and division of passenger receipts and it now awaits confirmation by the London Passenger Transport Arbitration Tribunal. The other intimation of note is that the Minister of Transport has approved of the scheme for the pooling of the receipts of the four grouped companies from parcels, excess luggage, and parcels post, excluding mails.

IN his Presidential Address at the annual meeting of the Manchester Technology Old Students' Association, Lieut.-Colonel W. G. Codling said that the section of the 1930 Road Act dealing with weak bridges was of the greatest importance to highway engineers. Where the owners of the bridge—a canal or a railway company—were satisfied that a road bridge was insufficient to carry vehicles beyond a certain weight, they could fix a plate on the bridge limiting the load to that weight, with heavy penalties for excesses. Railway and canal companies were making a thorough examination of their bridges at the present time, and when a date had been decided by the Minister of Transport, the bridges would be thus restricted. The effect of this restriction would be to paralyse road traffic throughout the country, and local authorities were considering what means could be adopted for strengthening the bridges.

SINCE the opening of the new section of Western Avenue, Middlesex, at the end of last year, West End-road has become a part of the main route between London and Buckinghamshire. The existing road between Western Avenue and the Great Western Railway bridge is extremely narrow, and there are several lengths on which no footpaths are provided. The County Council has submitted a scheme for the reconstruction and widening of this section of the road, at an estimated cost of £42,000, and Mr. Hore-Belisha has agreed to assist the Council to go forward with the scheme without loss of time. It is proposed to provide temporary cinder footpaths pending the completion of the permanent works. West End road branches off to Ruislip from the new and temporary terminus of Western Avenue, and the estates on both sides of the road in the neighbourhood of the Great Western Railway bridge are being rapidly developed.

IN view of the growing congestion in the streets of the Metropolis, Mr. Hore-Belisha, Minister of Transport, has decided to make a grant from the Road Fund for work to be resumed on the North Orbital Road, which will be the longest by-pass road in Great Britain. He has approved a scheme submitted by the Hertfordshire County Council for the construction of a further section of the road, 2 miles in length, from the Buckinghamshire–Hertfordshire border to West-Hyde Lodge, near Rickmansworth, the cost of which is estimated at over £50,000. The North Orbital Road was planned by the Ministry of Transport. It is designed as an outer semi-circular route north of London, starting from the Bath road at Colnbrook in the west, passing through the counties of Buckinghamshire, Hertfordshire, and Essex, and terminating at Tilbury in the east. In conformity with the other parts of the North Orbital Road, the new section will provide for a width of 100ft. between fences. It will have a 30ft. concrete carriageway with footpaths on both sides.

SPEAKING at the Institute of Transport on February 11th, in the discussion on a paper entitled "Goods Shed Operations," Mr. E. J. H. Lemon, the vice-president for railway traffic, operating and commercial, L.M.S. Railway, said that the wages cost of a goods station was tied up in cranes, conveyors, and the like. To rectify that lay-outs should be altered so that, instead of having a dozen cranes, wagons could be brought to a single crane. The goods station question had never been properly investigated in the past because conditions were not pressing, but to-day railways were suffering because their terminal costs hindered them in the fight with road competition. Apart from those expenses railways were still the cheapest form of transport. Earlier in the discussion, Mr. Whitelaw, who presided in the absence of Mr. Sidney E. Garcke, urged the importance of investigating goods shed operations on account of the large sums of money involved, but added that the effect of swifter and more efficient work in this respect would be wasted if it resulted in trains being ready to go on the line before there were paths for them.

Miscellanea.

FOR Marchese Marconi's experiments in micro waves a transmission station has been erected at Monte Rosa, near Rapallo, at a height of 2230ft. above sea level.

A NEW record speed for heavy oil engine-driven motor cars has been set up by Mr. D. Evans at Daytona. He is said to have reached a speed of 125·065 miles an hour.

THE Internal Combustion Engine Institute of the United States has issued standard rules for rating and testing internal combustion engines for industrial applications.

OIL engine exports from this country during 1934 are valued at £1,954,763, an increase of 39 per cent. over the 1933 figures. India was the best buyer, taking engines to the value of £364,213.

THE Postmaster-General has announced in the House of Commons that during the next three and a-half years thirty-seven million pounds will be spent on telephone development in this country.

THE estimated cost of buildings for which plans were passed by the local authorities of 146 of the largest towns in Great Britain during 1934 was £95,563,000, according to the returns of the Ministry of Labour.

FOR the year 1934 the total gold ore tonnage milled in the Transvaal was 40,055,750, compared with 37,192,410 tons in 1933; and the yield in 1934 was 10,486,393 fine ounces, against 11,017,495 ounces in 1933.

OF the 1550 exhibitors at the British Industries Fair, which opens at the White City and Olympia on February 18th, some 756 will represent London firms or activities; the Birmingham section of the Fair does not open until May 20th.

WORLD production of crude oil in 1934 amounted to 1,497,862,951 barrels, against 1,417,534,489 barrels in 1933, according to official figures from the governments of oil-producing countries; a barrel being 42 United States gallons.

THE Berlin correspondent of the *Financial Times* reports that a new form of unbreakable "glass" made of cellulose acetate has been invented by a German chemist. The material can be used for bottles, tubes, &c., is lighter than ordinary glass, and can be coloured.

THE engineering unions will meet the Engineering Employers' Federation on March 13th to discuss further the claim of the unions concerned for a general increase of 2d. an hour, with a corresponding advance for piece-workers. The claim also covers the restoration of the overtime, night shift, and piecework conditions operating before the agreement of June, 1931.

A NEW method of flame cutting metals has been introduced by Oxy-Ferrolene, Ltd., which uses a mixture of coal gas, impregnated with a special liquid, and oxygen. The cost of the system is stated to be lower by 40 per cent. as compared with acetylene, and to require less oxygen and to make a cut which is narrower, while the edges are not hardened. The effect of the impregnation of the gas is to lower the ignition point and retard the propagation of the flame so that its cutting value is increased to a marked extent.

A SIMPLE method for determining the solubility of nitrogen in liquid iron has been devised, states a publication of the American Institute of Mining and Metallurgical Engineers. The solubility, at approximately 740 mm. pressure, was found to be 0·039 per cent. just above the melting point and 0·042 per cent. at 1760 deg. Cent. Within the limits of experimental error, the solubility is not affected by 0·15 per cent. aluminium or by 0·70 per cent. silicon. The rate of solution of nitrogen in liquid iron is not greatly affected by temperature. The presence of aluminium or silicon in the melt exerts a very great influence upon the rate of solution.

AT the first annual general meeting of the British Oil Burner Manufacturers' Association, Ltd., the President, Mr. F. H. Horton, in dealing with the activities of the Association, referred to the fact that much time had been devoted to the consideration of a specification for minimum standards of design, manufacture, and installation of automatic oil-burning plants (domestic and central heating). Before very long, he said, it should be possible to issue the specification, which should be of much value to the industry. Mr. F. H. Horton was re-elected President for the ensuing year, whilst Messrs. F. L. Bolt, R. L. Nash, and W. A. Hubbard were re-elected Vice-Presidents and Honorary Secretary respectively.

THE necessity of ensuring uniformity of moisture content and thorough mixing of the material used in forming the refractory lining of a rotary furnace is generally realised, states a report of Mr. W. J. Rees to the British Cast Iron Research Association, but it is also important to obtain a proper union of the successive layers of material used in building up the lining. It is desirable to use a ramming tool with a somewhat chisel-shaped end which will force its way through one layer into the preceding one, and so bring about effective jointing and union of the layers. If a blunt-ended ramming tool is used, the successive layers are not united and a laminated lining is produced. A lining of this character is likely to shell off or spall when the furnace is heated.

AN extract in the *Automobile Engineer* describes a research carried out at Michigan College of Technology, U.S.A., on the value of copper as a cylinder head material. It has a higher thermal conductivity than aluminium alloys, but is somewhat heavier. Its thermal conductivity is influenced by its purity, but the presence of silver tends to increase the conductivity and also the hardness. Tests were carried out on a single-cylinder engine with heads machined from cast iron, aluminium alloy, and cast copper, and with a series of compression ratios from 6·0 : 1 to 8·5 : 1. The spark advance for incipient knock was determined for each of the heads, while the revolutions per minute, manifold suction temperatures, &c., were kept constant. It was demonstrated that, for the same spark advance, a higher compression ratio can be used for a copper head, *e.g.*, 8·0 : 1, compared with 7·5 : 1 for an aluminium head, and 7·0 : 1 for a cast iron head.

Air and Water.

FOLLOWING the successful shortening of the liner "Mathura," Smith's Dock Company has been given an order by the Brocklebank Line to shorten the "Mangalore" by 30ft.

THE new Royal Air Force No. 6 Flying Training School, which is being established under the expansion scheme, will form at Netheravon in April, and the first course will begin the following month.

THE Portuguese Government has ordered six Blackburn "Shark" torpedo-bomber seaplanes for use in its Navy. This type of machine, with a load of 1500 lb., has a range of 625 miles at 110 miles an hour.

IT is computed that some £8000 per annum will be lost to the business community of Plymouth through the transference by the French Line (C.G.T.) of its outward services from that port to Southampton.

THE Air Ministry has decided to place an order, subject to completion of contract negotiations, for a number of Saunders-Roe "Saro" twin-engined "general-purpose" flying boats. These aircraft will replace obsolescent craft now in service with R.A.F. squadrons.

Two new air speed records for air liners have been made by Luft Hansa machines. One, carrying nine passengers, flew from London to Amsterdam, a distance of 220 miles, in one hour; the other, carrying freight and mails, covered the 320 miles to Cologne in 92 minutes.

THE Deutsche Luft Hansa has completed a year's successful operation of its South American mail service. In all, fifty-six crossings have been made, using first the "Westfalen" and later both this vessel and the "Schwabenland" as catapult and supply ships.

THE Norddeutscher Lloyd liner "Europa" is to be laid up in the yards of Blohm and Voss at Hamburg on March 1st for engine repairs. A report that entirely new engines were to be put in so that the liner might compete with the new French liner "Normandie" has been officially denied.

DURING an exceptionally fierce gale which swept Western Germany, seven out of eighteen balloons which were to have taken part in the German balloon race from Darmstadt, were torn from their moorings and blown away. They were only half inflated, and had no baskets attached.

THE President of the Board of Trade said in the House of Commons that the tonnage of tankers of 1000 tons and upwards launched in Great Britain and Ireland during 1934 was 69,066 tons gross, and the tonnage of tankers under construction at the end of December, 1934, was 94,000 tons gross.

SPEAKING in the House of Commons the Minister of Transport, Mr. Hore-Belisha, said that the London Passenger Transport Board had informed him that it did not propose at present to establish passenger services on the Thames. He further said that he was unable to state the intentions of other parties as to the provision of such a service.

ACCORDING to the Rotterdam correspondent of the *Journal of Commerce*, Dr. H. Colijin announced in the First Chamber of the Netherlands Parliament that the Government has decided in principle to render financial aid to the national shipping industry, and a scheme is now being prepared which will probably cost approximately 6,000,000 guilders for the present year.

THE relative amount of employment involved in the building and the scrapping of ships was exemplified by some remarks made by Dr. E. L. Burgin at the annual dinner of the Glasgow Shipowners' and Shipbrokers' Benevolent Association. He said that it required 42,000 men for twelve months to build 1,000.000 deadweight tons of cargo vessels; while 6600 men employed for the same time could reduce twice that amount of tonnage to scrap.

AN order has been placed with the Netherland Shipbuilding Company, Amsterdam, by the Soviet Government for the construction of two motor ships of about 3500 tons deadweight each, specially designed for the carriage of timber cargoes. The design of these vessels ensures an entirely clear deck for cargo handling, with high-level cranes fixed to the masts instead of derricks, and an improved arrangement of water ballast tanks. The ships are to be propelled by Stork Diesel engines of 1500 h.p., which will give them a speed of 11 knots.

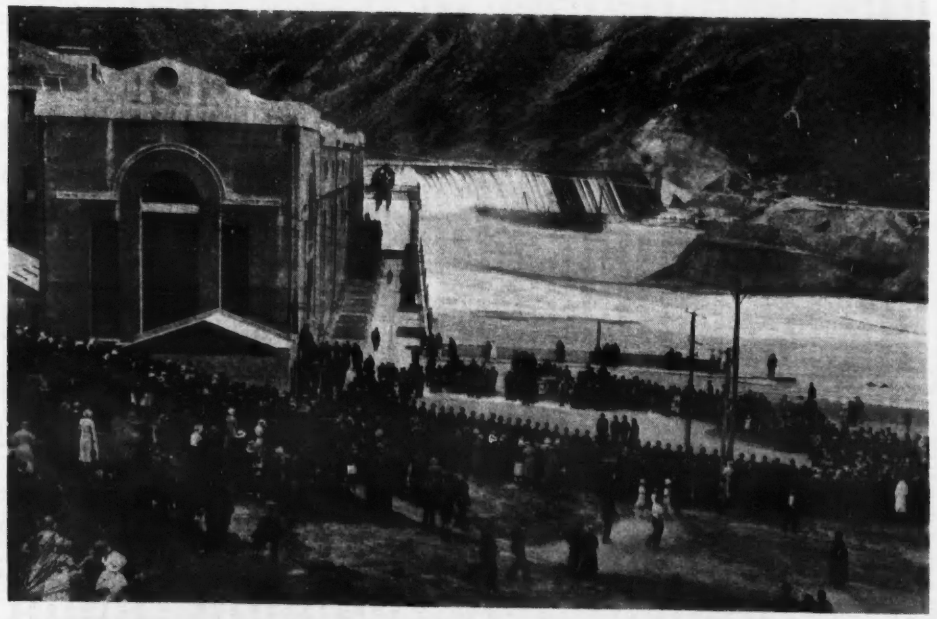
THE Speke air port, near Liverpool, is to be extended at an estimated cost of £100,000 by buildings 350ft. in length and four storeys high for the accommodation of passengers, pilots, staff, and other officials. There will be lifts and a flat roof will give access to the control tower, centrally placed in the building. There will be radio equipment, and flanking the building will be two large hangars. It is expected that by midsummer the central control tower and one of the hangars will be built and the lighting equipment will have been installed.

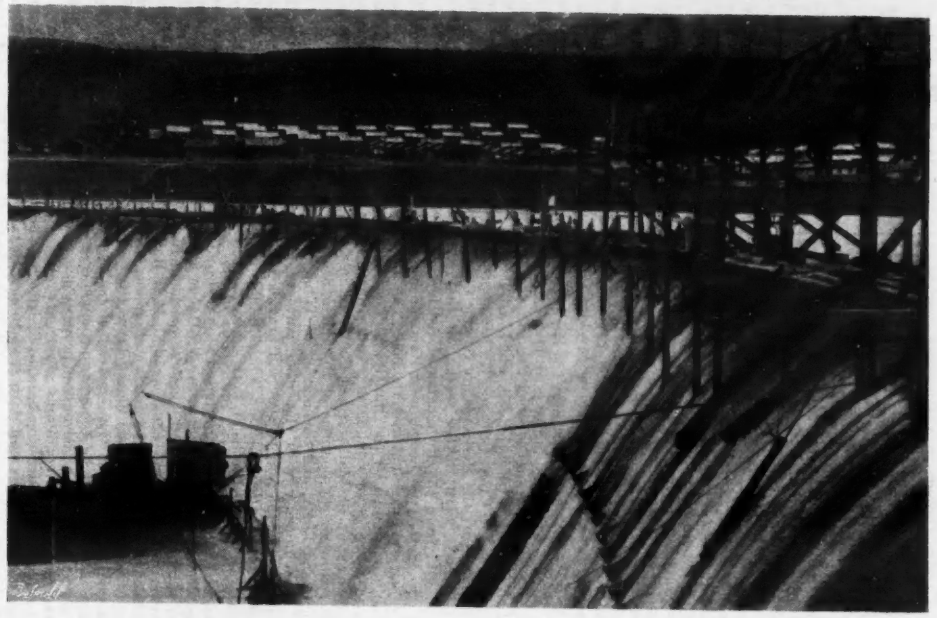
AT a recent meeting of the Royal United Services Institution, Mr. G. O. Williams gave some particulars of the £1,000,000 scheme to provide a chain of seadromes—or floating islands for aeroplanes—across the Atlantic. He stated that £100,000 had already been spent on preliminary testing and development work and that model seadromes had passed all the tests of the American naval authorities. It was, he said, proposed to place seadromes north of the present South Atlantic air route and south of the direct northern route. A seadrome would consist of a structure weighing 26,000 tons, and would require 50,000 tons of water ballast.

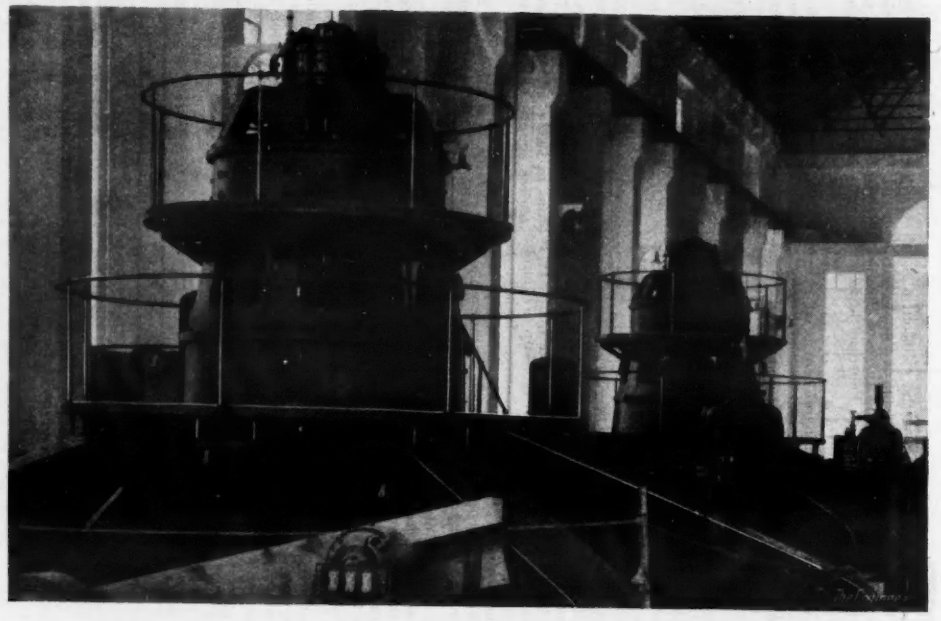
A NOTE from its Paris correspondent in the *Financial Times* says that, according to Monsieur Cangardel, managing director of the C.G.T., which owns the new liner "Normandie," there are only fifteen liners which, by their tonnage and speed, could compete with one another on first-class lines. Of these fifteen liners, four have been in service for more than twenty years. Four others are already out of service, or nearly so. In all probability, he added, the cost of running the "Normandie" would be 4,000,000 francs per journey. This does not include the amortisation of capital, and the company hoped that the Government would give assistance in paying it off.

THE WAITAKI DAM AND POWER HOUSE, NEW ZEALAND

(*For description see page 194.*)







ABOVE:—OPENING CEREMONY OF DAM AND POWER HOUSE
BELOW:—SPILLWAY OF WAITAKI DAM

ABOVE:—WAITAKI DAM AND POWER HOUSE
BELOW:—INTERIOR OF POWER HOUSE

The Engineer

FEBRUARY 22, 1935.

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SIXTEEN-PAGE SUPPLEMENT—"THE METALLURGIST."

NOTICES TO READERS.

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The Metallurgist.

THE FEBRUARY NUMBER OF THE METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

AIRCRAFT AND MOUNTAINS.

WHEN the practice of flight was still in its infancy one of the most frequently prophesied sources of accident to which flying machines were likely to be exposed was collision in the air. After a quarter of a century's experience we may safely say that in civil flying the risk of collision is not serious; largely, no doubt, because of the excellent system of ground control applied to machines on the regular air routes. In military flying, with its manœuvres in close formation and other operations involving the flight of more than one machine within a limited space, collisions have been the cause of a number of accidents. It can, indeed, be asserted that nearly every instance of collision in the air which has occurred has been between military machines. A kindred source of disaster, the collision of an isolated machine with a hill or mountain side, has, somewhat unexpectedly perhaps, proved to be among the serious risks attending flight under certain conditions and in certain districts. We recall in this connection the disaster which overtook the first Fairey long-range monoplane when it crashed into the Atlas Mountains on an attempted non-stop flight to South Africa. We recall, too, the fate which befel that most skilful pilot, Mr. Bert Hinkler, when flying across Italy, and the crash in Germany on January 31st this year when a Deruluft passenger machine flew into the side of a hill near Stettin. There have been many other accidents of a similar kind. To them we have now sorrowfully to add the disaster on Friday, February 15th, when a "Singapore" flying-boat—one of four on a flight to the East—crashed into a mountain side near Messina, Sicily, with the loss of nine lives. By their very nature accidents of this kind are nearly always fatal to all on the machine involved, and nearly always the machine is so completely wrecked that it is impossible afterwards to discover the immediate cause of the accident. Carelessness on the part of the pilot can hardly be advanced as a general explanation, for, very conspicuously, those concerned have included some pilots of high skill and long experience. In one case, at least, the machine was actually fitted with an automatic pilot although the system did not, we believe, extend to the automatic control of altitude. Whatever may have been the immediate causes of these distressing accidents they all have this much in common: in each case the pilot, consciously or unconsciously, was flying at an altitude less than the height of a hill or mountain in his immediate neighbourhood. Trite as that statement may sound it is just possible that it may provide the basis from which to develop means for the avoidance of further accidents of this kind.

It is to be noted that in a considerable number of cases collisions with mountains have occurred in the dark or during the prevalence of fog. In the German disaster at the end of last month it seems very probable that the machine had been forced down to an unduly low height by the accumulation of ice on the wings. Possibly, although not certainly, the pilot in this instance knew beforehand that his altitude was low but, in general, we must suppose that pilots who have crashed against mountains have been in ignorance either of their true height or of their exact position on the map. It is possible that in some cases accidents have been classed as collisions with mountains simply because some structural or engine failure occurred while the machine was traversing a mountainous region which gave the pilot no opportunity to seek a safe landing ground. We exclude mishaps of this nature from the present discussion because they involve general considerations of the strength and trustworthiness of aeroplanes and, only in an incidental degree, the existence of a mountain in the region of the mishap. We must, too, exclude the remote possibility that in flying across certain mountainous districts an aeroplane may be subjected to unknown abnormal forces or circumstances which upset its behaviour and customary control. Various physical effects might be suggested as grounds for such a possibility. It is possible, for instance, that in passing over a mountain an aeroplane may be affected by a phenomenon similar to that of "suction" between ships—as exemplified in the collision between the "Hawke" and the "Olympic"—or, more congruently, between a barge and the bank of a canal. More rationally it may well be supposed that the abnormal meteorological conditions, including wind currents and eddies, in the neighbourhood of a mountain may play some part in the problem. We dismiss these sundry explanations either as unlikely, remote, or exceptional and turn to that which was first suggested, the simple fact that the pilot in a mountain crash is ignorant of his true height or geographical position. So long as altimeters of the aneroid type are relied upon as indicators of altitude, so long must pilots of machines on extended flights remain in some doubt as to their true height. The zero of the altimeter reading is derived from the known elevation of the last point of departure and the barometric pressure prevailing at it at the moment of taking off. Unless that zero is subsequently corrected by wirelessed messages, a fall in the barometric pressure or the passage of the machine from a region of high to a region of low pressure will result in the altimeter giving a spurious indication of height. It will be recalled that an explanation of this kind was advanced to account for the destruction of the British airship "R 101" at Beauvais. It is possible that in the neighbourhood of some mountains the normal, somewhat arbitrary, rate of decrease of pressure with altitude, relied upon by international agreement in the scaling of altimeters, may be departed from to a sufficient extent and in the required direction to give a dangerously false indication of altitude. As regards the pilot's ignorance of his precise geographical position we have only to reflect upon the non-exact means which he has for determining it to realise that, in conditions of poor visibility, safe flight over a mountain range demands an altitude greater, by some good margin, than the height of the highest peak of the range.

The problem of avoiding collisions with mountains is akin to the problem of avoiding the stranding of a ship on a reef or submerged rock. There are two essential differences only and both are in favour of the aeroplane. The ship is, as it were, confined to one altitude and cannot take steps to avoid a possible disaster by rising to a higher level. Again the mountains and hills of the world, their height and situation are far more accurately known than are the rocks and reefs of the sea. It would therefore appear safe to say that the collision of an aeroplane with a mountain ought to be at least as remote a risk of air navigation as stranding on a rock is in navigation by sea. The practical means of avoiding the risk may not, however, be identical in the two cases. It would doubtlessly be impracticable—and on the whole not very much to the point—to erect lighthouses or fog sirens on the tops of mountain ranges or hills traversed by aeroplanes. Possibly, too, it would be found unsatisfactory or useless to resort to the use of aerial echo range sounders working on the same principle as the depth sounders employed at sea. With a machine flying head on for a mountain at half the speed of sound in air, the echo from the mountain side would be received after the machine had travelled two-thirds of the distance towards destruction. The interval left for the recognition of the danger and for taking steps to avoid it would probably be fatally short. Some new means of detecting when a mountainous mass is being approached is required. It must not give simply an indication of the existence of a mountain in the neighbourhood but must inform the pilot concerning the bearing of the highest point of the mountain both in the vertical and the horizontal plane. Is such a device or instrument beyond the limits of man's inventive ability? We would be loath to think so even if we did not know that it is already almost halfway towards being realised. In connection with the kindred problem of collision between two aeroplanes an instrument, we understand, is now being developed in Germany by means of which the pilot of a machine may be automatically warned of the presence of another machine within a given range of his own. Again, for the purpose of determining the height of an aeroplane above the ground two electrical methods, one based on the reflection of electro-magnetic waves from the ground surface and the other on the change in the electrostatic capacity of a condenser on the aeroplane, have been tried. It may not be easy to develop these devices, or others similar to them, into instruments with a usefully effective range in the horizontal direction. Taken together, however, they seem to justify the belief that it will be found possible to provide the pilot of an aeroplane with a means which will indicate to him when he is in dangerous proximity to a mountainous mass.

The Port Eglinton Junction Railway Accident.

THE safety with which British railway companies carry their passengers is nothing short of marvellous when the density of the traffic is considered and we remember how much is dependent upon the care exercised by enginemen and signalmen. It was, therefore, not only unfortunate, but somewhat of a coincidence that after a lapse of fifteen months without a serious accident there were two in September last. Moreover, the total number of passengers killed last year in train accidents was higher than in any year since 1928. The two in September last were the collision of September 6th at Port Eglinton Junction and that at Winwick Junction on the 28th of the same month. The Ministry of Transport report, by Colonel Trench, on the latter appeared on January 3rd, and was reviewed in our issue of January 11th. The Port Eglinton Junction collision was inquired into by Colonel Mount, but as the driver concerned in that accident had to stand the charge of culpable homicide, that officer's report was held back until the criminal proceedings were concluded—in the unanimous verdict of "Not guilty" by a Sheriff's jury on January 30th—so that any opinions expressed in the report should not influence, either favourably or adversely, the man's trial. We speak above, as we have done on many other occasions, of the care exercised by enginemen and signalmen. Winwick Junction was a case where the signalman was at fault. It was an instance of what Colonel Trench's report described as "mental lapse." The man was concerned over the order to be taken by a sequence of trains, and, happening to see that one of his block instruments recorded the presence of a train in the section, he jumped to the conclusion that it referred to a train that had passed ten minutes earlier, and which he imagined he had failed to clear. He thereupon sent the train-out-of-section block signal for a train that was actually standing at his signals 200 or so yards away, and accepted the express; the collision followed. As it may be urged that the man should have some safeguard against his making a lapse of that nature, it should be noted that such protection is afforded by the train register book, which records the times

of the sending and receipt of all block signals. Winwick Junction happens to be the dividing line between two traffic control areas, and there is, consequently, a considerable amount of telephoning. For that reason the train register is kept by a youth. These lads are usually so expert in their work as to be a capable watch over the signalman's movements. Unfortunately, the youth in this case had, at what was to be the crucial moment, to leave the train register and busy himself over some arrangements for the running of certain special trains. He heard the signalman make a remark as to not having cleared the block instrument, but assumed that it was for the local train—the one then standing at the signals—which, he thought, had passed whilst he was engaged elsewhere. It is safe to say that otherwise he would have restrained the signalman. For fear it should be thought that this was a haphazard kind of security, we would say that it is the general practice now to provide track circuit in such positions as that taken by the waiting train, and that Winwick Junction was on the list of places to be so equipped in its turn.

The Port Eglinton Junction collision, on the other hand, was due to an error by a driver. We do not find the least difficulty in furnishing an explanation for that man's lapse. From a personal inspection, we saw that, on leaving Shields-road Station, there was a sky view of the home signal for the down main line at Port Eglinton Junction box. The home signal for the down Canal line, which was the one the driver needed, was a much lower signal and did not come under our notice for some distance afterwards; moreover, owing to the curvature of the line, the former signal appeared to the right of the Canal line signal, instead of to its left. As the Canal lines are, in the direction of running, on the right of the main lines, the situation is confusing. The driver did not, however, take that line of defence; he said he knew the road thoroughly well, and had done all his firing on it. His version was that when he sighted the down Canal line home signal it was at "clear," and that after he had turned round—his engine was running tender first—to open the second regulator valve and to notch up the engine to take the train up the 1 in 86 into Cumberland-street Station, he found, on again looking at the signal, that it was at "danger." It must now be noted that, additionally to the two trains concerned in the collision, there was a third which was one from Ardrossan on the down main line. All three were approaching Port Eglinton Junction at about the same time, but one or other of the first two would have had to be pulled up, as they were on routes that crossed each other at that box. There was, however, nothing to delay the Ardrossan train, and the down main line home signal was put to "clear" for it. That probably was the first signal driver Kerr saw—certainly the only one in the "off" condition—and our suggestion is that, though he knew the road, that signal at "clear" so influenced his mind that he turned round to increase his speed, and so missed seeing the adverse condition of his own signals. A good deal was made at Kerr's trial of the fact that within twenty-four hours of the Ministry of Transport inquiry on September 11th, a change was made in the block-signalling methods at this box. Though that fact no doubt contributed to the man's acquittal, it is right to record that the procedure which was changed did not in the least contribute to the man's alleged failure to observe and obey his signals. The point which was irregular was that in junction working the signals for trains that conflict should all be kept "on" until both trains had been brought to a stand, and, as Colonel Mount observed, "the Kilmarnock train should not have been permitted to cross the path of the Paisley train until the latter had come to a stand." Instead of that, the procedure, for thirty years, had been to read an instruction that "when the down main or down Canal line is clear to this box" to mean the whole area protected by the box. That, as said above, was at once altered when the facts were made known at the inquiry; moreover, Colonel Mount relates, an investigation with regard to the methods of operation at all the junctions on the L.M.S. system in Scotland is to be put in hand, with a view to securing uniformity.

Whilst it is much to be regretted that these accidents occurred, some satisfaction may be found in the fact that though some 1200 million passenger journeys were probably made last year, there were only two accidents in which passengers lost their lives. It is safe to say that railway accidents cannot wholly be avoided, but the tendency is, year by year, to reduce their number. In both these cases methods are available which would have avoided them. At Winwick Junction track circuit had been ordered, but its installation was waiting for places that needed it more to be first dealt with. Port Eglinton Junction is on the very edge of the St. Enoch colour-light signalling installation; in fact, the up home signals are of that type. With colour-light signals a better running view is given, and driver Kerr would also have had a more definite warning of his approach to an obstructed junction. It may be noted with satisfaction that the final words in the report refer to "the company's prompt action to prevent recurrence of such accidents."

Representative Samples and Commercial Testing.

By A. HAAS, M.I. Mech. E.

A PROBLEM inseparable from the acceptance of bulk materials and products is the extent to which random or other samples are truly representative. It is impossible to test to destruction the whole of a supply; as a consequence, reliance must be placed on the tests of typical or representative samples. In framing acceptance test conditions, it is desirable in many cases to specify in detail the manner of sampling as well as the number of samples, together with the actual tests to be applied. All who are familiar with the compilation of effective specifications and their enforcement are aware of the difficulties. On the one hand, to insist upon an undue number of samples involves additional cost; on the other hand, single samples are in general not representative. The position should, of course, be made clear in the specification or the order, and not be left to argument or arrangement after the order is placed.

Representative sampling, in most cases, is quite as important as exactitude in carrying out prescribed tests, and when formulating the conditions of sampling, and the number of tests related to any given bulk, due regard must be paid to the process of manufacture and to the nature of the case. Some materials are inherently uniform, while others are inherently and unavoidably irregular. It is obvious that in the latter case greater attention must be paid to sampling, and a larger number of samples be taken to be truly representative.

Coal is an outstanding instance where an elaborate technique of sampling is essential to obtain representative samples for analysis or for bomb calorimeter test. One thousand tons reduced finally to 10-gramme laboratory samples involves initial sampling at random, division, and subdivision again and again, and needs uncommon care and precaution.

Sampling Iron and Steel.

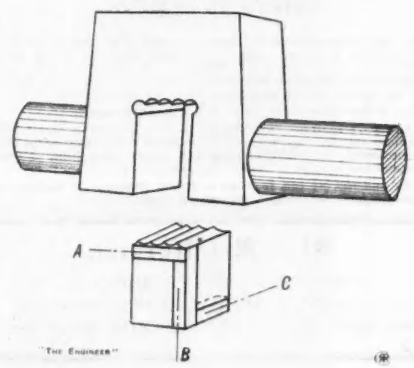
Pig iron is an instance of inherent irregularity even when the bulk sampled is the product of a short time interval from a single blast-furnace. Not merely do the pigs vary mutually among themselves, but inherent irregularity exists as between skin and core in the case of each individual pig. When, for good reason—as for use in the manufacture of high-grade steels—certain elements are confined to narrow maximum limits, proof that the material complies with requirements depends as much on the methods of sampling as on the care taken in chemical analysis. After the requisite number of pigs has been chosen at random, one method is to break each at mid-section, drilling inward at various points on the fractured surfaces, bulking, dividing, and sub-dividing, as in the case of coal, to samples of laboratory size. But, with all this care, the presence of skin sand inadvertently introduced in the process of drilling may render the sample far from representative.

In a single cast of open-hearth steel a single sample can, for most practical purposes, be held to be representative as the cast is uniform throughout within a narrow margin. Crucible tool steel being the product of very small melts, all casts will differ, and in a bulk of such steel a single sample cannot be representative.

For reasons of inherent irregularity no two samples taken from a bulk of finished puddled wrought iron will give similar results. Each original puddled lump may weigh only 1 cwt., and 4 cwt. may be taken as the maximum production at a single heat. Piling, repiling, and working down to finished size tends to diminish inequalities, but the fact remains that it is common to find tests from the reverse ends of a single bar differing appreciably in result. While one cast analysis and one test from a cast of open-hearth steel may be representative, in the case of wrought iron a substantial percentage of any bulk is normally expended in test to ensure that the material is uniform and complies with requirements. One set of tests from 5 tons of wrought iron compares with one set of tests from 50 tons of open-hearth steel.

The selection of representative samples or test pieces from castings and forgings is necessarily more complex. The metal in a casting varies according to position, test pieces cast on may bleed or be bled, and their size alone precludes them from being representative. Test samples separately cast are usually preferable, but can only represent the metal used, not the metal in the final casting, and variation must exist depending upon whether the test pieces are run at the beginning or the end of a melt. One difficulty with separate test pieces in this connection is that unless the pouring is independently witnessed, reliance as to identification must be placed on the foundry. Bulks of small castings are best treated by selection and tests to destruction.

Representative test samples from forgings depend upon the nature of the case, and no general method can be given. Normally, and for obvious reasons, the test pieces should be taken from the least-worked portion of the forging, but in many instances this is impracticable. Crank shafts are a typical instance of large forgings in which the position of the test pieces is of great importance. The largest cross section in the forging is that of the webs and the web block, sawn or otherwise removed before machining, affords the most convenient location for test pieces, which are thus taken from the least-worked portion of the forging. From such a block tensile and bend specimens can be taken in three dimensions, as shown in the sketch:—A in axial line, B transverse



to axial position in line with webs, C at right angles to B. The results obtained from three such test pieces will be in descending ratio in the order stated. From experience the results from test piece C are discordant, inconsistent, and not representative. Results from test piece A are approximately 10 per cent. better than from test piece B, which is normally taken as representative if the crank shaft is forged from a bloom or ingot of adequate size. A test piece obtained by forging down the end of the shaft is obviously not representative of any portion of the crank shaft. In a crank shaft cranked by bending, or of insufficient throw to give a test specimen from a web block, a test sample taken from the full diameter of the shaft end midway between centre and circumference can be considered representative; but, wherever possible, the test specimen should be taken from the web block.

In the case of important forgings, the initial billet, ingot, or bloom should be of, at least, twice the cross-sectional area of the largest cross section of the finished forging. Commercial hammered bars should receive equal forging.

Non-ferrous Bar and Spring Steel.

Extruded non-ferrous bar is produced from small melts, and as piping is to some extent inevitable, it is manufacturing practice to fracture back to a sound section on first examination. By reason of falling temperature and the difference in the work during extrusion at the beginning and end of the process, extruded bar is liable to show differences in physical characteristics at the ends of each bar, which rectification of section by subsequent die drawing tends to minimise, but does not remove. Fractured ends to show soundness are or should be open to inspection, and test samples taken from a bulk sawn to finished length should be sufficient in number to render them representative.

Spring steel in the billet form, without further manipulation into bar, cannot give camber or coil spring tests essential to confirm the results of analysis. If the bulk is from a single cast, analysis will not differ materially, and a single billet from each cast, rolled

to appropriate bar form for camber or other spring test, should be representative.

MANUFACTURED PRODUCTS.

In the case of typical manufactured products, of which chain and bolts and nuts are two examples, prior test of the material does not ensure that the subsequent bulk is made from the tested bar as the product carries no evidence to identify the original material. In the case of chain, the difficulty was solved in B.S.S. No. 394 by devising tests on the finished product to ensure that iron of appropriate quality was used. The particular matter upon which reliance is now placed in crane chain is a specified minimum elongation in the chain at a predetermined specified test load.

In bolts and nuts, tensile tests on finished bolts are essential to determine that a prescribed material has been used; finished nuts cannot be so tested, and reliance must be placed on deformation or expansion tests.

Selection of representative samples from a bulk of finished articles introduces the law of probability, alias luck. The inspector is lucky if he picks random samples which fail, and the maker is fortunate if the inspector selects samples which give the specified results in cases where the bulk is not uniform or has been made from untested assorted stock material. Manufacturing methods and control of raw material are of the greatest importance, and when satisfactory may rightfully diminish the quantity of samples selected. Unsatisfactory or casual methods necessitate greater care and discrimination in the selection of representative samples. Manufacturing method, precaution and control divide the first class from the second-rate maker. The latter can often cut prices below the former by disregard for uniformity and reliability. Familiarity with the methods of good and inferior makers guide the initiated in the matter of representative samples.

Samples taken at random or samples taken indiscriminately are terms frequently used, but both are open to criticism, and do not represent what is actually intended. Selection must be systematic to ensure representative samples and the division and subdivision normal to coal and pig iron should be practised.

In a bulk supply of articles, such as rivets, these are often presented in open-mouth 1-cwt. bags, and in the case of other small articles may be presented in trays or receptacles, all containing approximately equal quantities. Examination for make and finish involves the detailed examination of a percentage, unless there is good reason why each individual piece must be examined in detail, as in the case of aeroplane parts.

A percentage having been settled, it then remains to adopt a method. Taking the convenient illustration of rivets in open bags; one bag in a given number selected indiscriminately is emptied, the contents cursorily examined, and the quantity doubled by selection from the remaining bags from varying levels. The selected whole is then bulked, divided, and subdivided into a convenient parcel for detail critical examination of each individual piece. Taking the bulk as 40 cwt., 5 per cent. means the contents of one entire bag and an equal quantity indiscriminately selected from the remainder, *i.e.*, 2 cwt.; by subdividing this quantity into two parts and repeating three times a residual quantity of 28 lb. is obtained, which can be regarded as representing the whole supply. On grounds of common sense and assuming variation, such a residual quantity should contain specimens of all variations with reasonable probability. Unless sampling is methodical, as well as indiscriminate, it cannot be representative. From the residual quantity test samples can be drawn to prove integrity of material by test.

Bulks of other materials or products may compel variation in the procedure, but the method outlined is obviously better than selecting odd samples by caprice without system.

In the event of dissatisfaction with the critical examination of the residual quantity so chosen, larger quantities should be selected by the same method, and, if necessary, the maker should be compelled to re-sort the bulk. Acquaintance with the processes of manufacture will determine the percentage of first and second selections, and if first cursory examination reveals an appreciable quantity of defective articles it is obviously useless to proceed further.

The matter is dealt with at some length, as without method and system sampling and examination is likely to become casual and even experienced inspectors are liable to trip where the bulks are of considerable size and the makers' works familiar ground. Large bulks should be separated into definite multiple parcels, each parcel being treated individually and without reference to the remainder. It is desirable to stipulate the unit to be treated as an independent bulk.

Reputable makers of manufactured products open to inspection before acceptance rightly object to casual methods and also to undue detail examination. If the 4,000,000 rivets for the new Cunarder were inspected on the same basis as aeroplane parts the makers would have good reason to object; on the other hand, casual sampling affords no protection to anyone concerned.

Repeat tests in double quantity in case of failure are usually included in recognised specifications, and are sometimes optional, and in other cases compulsory. Makers claim either a second event with doubled chances of failure or independent test elsewhere.

WIRE ROPE.

Wire rope is an instance in which representative tests are of unusual importance. While the wire mills are presumed to test each and every coil of wire before delivery to the ropemaker, the latter from experience has found it necessary to re-check each coil of wire before stranding. Conformity to specification in single wires taken from the finished rope is dependent upon such initial precaution. It is unusual, but not unknown, for all the wires from an important finished rope to be subjected to test, but normally a proportion only is so tested. Makers having taken every possible precaution cannot guarantee that in manufacture an occasional wire has not been scraped, which may result in failure under test when taken from the finished rope. As a consequence if one wire from the number taken fails, a further equal quantity is subjected to the same test. Standard specifications reject the rope if more than one wire from the second set of samples fails. Testing in this wise on a small proportion of finished wires may involve an undue percentage of permissible failures, and when there are three failures from sixteen to twenty wires, discriminating purchasers insist upon testing all the wires in the rope.

Cases occur in all materials where out of multiple tests one or more fails by a small margin, and whilst cases of the kind are often dealt with on a general average basis, there is an element of common sense which does or should operate in acceptance. There are other cases where the whole of the tests may fail by very small margins. Such border-line cases should be decided on their merits, having regard to the ultimate purpose of the material or the article concerned.

TESTS AND TESTING.

Instances occur where the test method is itself at fault, for wide differences exist between laboratory and commercial testing, the former being carried out with scrupulous care and exactitude and the latter by more rough-and-ready means. Testing machines may be slow or fast and actual manipulation under test in some instances affects the result. The means of testing should invariably be appropriate to the material tested; it is possible to crack a nut with a steam hammer, but it is not common practice, and when the means are out of scale the results are liable to inaccuracy. A recent instance may point a moral. A wire rope sent for break in full section to a chain test house failed to give the specified break of 60 tons by a few hundredweights. As the wire average was consistent and above mean range, a further sample from the same rope was forwarded to a more experienced test house. The second result was 8 tons higher than the first, the explanation being that gripping the end of a sizeable rope in short taper curved grips is essentially inferior to capelling by means of a white metal cone, which gives an equal pull on all wires.

Another failure in the case of a smaller wire rope was found to be due to testing by means of tying a knot in each end of the rope and testing by two discs with central holes; the method was ingenious, but entirely out of place.

Commercial testing as practised at many steel works is far too rapid to be accurate. Independent tests are liable to show considerable discrepancy from makers' certificates. The deliberation and care of a research laboratory is out of the question, but the piece work rapidity of a steel works test house could with advantage be slowed down. One method to ensure greater deliberation is to require yield point to be given with tensile results, which necessitates greater care and slower procedure. While research in the case of bend tests aims to relate the stresses imposed in such testing with tensile results including elongation, commercial bend tests are meant to prove ductility and workability as apart from minimum tensile and elongation. Failure under the bend tests usually specified is exceptional, and rapidity in making commercial bend tests may be permissible. Deliberation is consistently practised in the case of wrought iron, in which large reduction of area is critical, and it is usual to allow a period dwell after yield to give the fibre in the specimen time to slip.

Another matter associated with tensile testing is that the available means of measurement often leave room for criticism. When failure is experienced and repeat tests are in question greater deliberation, care, and accuracy are generally evident. In cases of dispute ordinary common sense care is apt to be considered "laboratory" in the commercial steel works test house accustomed to more rapid methods, and final resort to independent test elsewhere is liable to be resented. Accuracy of measurement is of obvious importance in obtaining consistent results.

It is difficult to get the research worker to appreciate the limitations of commercial testing, and equally difficult to get the steel works test house to appreciate laboratory testing; the two are poles asunder in their points of view. The "snatch and grab" inseparable from the methods of an overworked commercial test house are entirely alien to metallurgical research. Both parties could with advantage benefit from first-hand acquaintance with the methods of the other.

Representative samples tested commercially affect the entire engineering community, the values involved are enormous, the snags manifold and are unrealised except by those who perforce are responsible for the quality and integrity of large bulks of material for important purposes.

The designer proposes, the maker of the material disposes; it is remarkable that so much is taken on trust by those who work up stock material into finished products. Where safety to life and limb are involved representative samples and proper testing are of supreme importance, and it is as well to add that it is more often detail than design which involves casualty or failure.

Individuals and authorities entrusted with the acceptance of large value bulks of material or products find many problems, a few of which only are dealt with in this article.

Activated Carbon from Coal.

By A. E. WILLIAMS, F.C.S.

THE product known as activated carbon is a material consisting chiefly of carbon itself, which has been specially treated so as to open up and enlarge its surface area, and thus to increase its adsorption capacity. In comparison with charcoal —which has long been used for the purification of water, decolorisation of sugar liquors, &c.—activated carbon is far more economical and efficient in use, for, owing to its highly active surface, a much smaller quantity suffices for a specific duty. It first came into prominence during the late war, when it was used in gas masks by all the belligerent countries for the adsorption of poisonous gases. Since the war its applications in industry have been gradually extended, and at the present time it is almost universally used for sugar and oil decolorising, the purification of water, and by chemical works for the extraction of undesirable impurities in liquors before crystallisation. It is also extensively employed for the recovery of solvent vapours in various industries, in addition to numerous, as yet, minor applications.

In spite of the tariffs now operating, a large proportion of the activated carbon used in Great Britain is still imported, chiefly from the Continent, where it is produced by several large concerns. The properties of activated carbon are governed to a great extent by the nature of the raw material used. For decolorising uses a finely powdered carbon is generally preferred, the raw material being coal, wood, peat, or waste vegetable matter, such as rice-hulls, &c. Carbons prepared from coal, in addition to being good decolorisers, are hard and dense, and are specially applicable to the adsorption of gases and vapours; also for the purification of water and other liquids. So that, with the rapid increase of solvent recovery plants and other systems in this country for which the special type of carbon from coal is required, an impetus has been given to its manufacture here. Its production is not an unremunerative proposition when one considers that the price of activated carbon is generally from thirty to forty times that of coal. The fact that by-products, of value as a motor fuel, are simultaneously produced, renders the process still more profitable.

PREPARATION OF RAW MATERIAL.

An advantage of activated carbon manufacture is that grades of coal which do not command high prices as such may be successfully utilised, providing that the ash content is moderately low. The coal selected, if in lump form, is first passed through a coal breaker, preferably of a type which reduces to a definite size in one passage of the coal through the plant. Slack from screening plant may be also advantageously employed; but as all coal, in its natural state, is a non-homogeneous mixture, it is necessary to reduce it to powder to secure a uniform product, and to facilitate the activation process. The next step in the process is the making of the powdered coal into blocks or briquettes. From the point of view of carbon content, anthracite forms the best raw material, but, unfortunately, this class of coal does not lend itself readily to the formation of blocks. So that when this coal is used alone, some form of binder must first be incorporated with it before briquetting. Such binders in use on the Continent are starch, glucose, high-temperature coal tar pitch, and petroleum products. The binder is added to the powdered anthracite in the proportion of about 0·5 per cent. by weight of the coal. The addition of the binder raises the retentivity, but

simultaneously increases the friability of the mixture, and this renders necessary a higher briquetting pressure to form suitable blocks for handling.

Bituminous and lignite coals, while not producing a carbon as efficient as the anthracite product, have much better caking properties; thus, when these coals are used in admixture with anthracite, a binder may be dispensed with. Generally, a mixture of 1 part of pulverised lignite or bituminous coal to 4 parts of anthracite gives the best briquetting properties. The machinery used for briquetting is well known in connection with the production of blocks of compressed fuel for domestic use, &c. For carbonisation purposes the briquettes are normally made to a size of about 4in. cubes.

Carbonisation.

Carbonisation takes place in vertical iron retorts, at a temperature sufficiently high to remove all volatile matter, but not high enough to "crack" the evolved gases; for carbon produced by the cracking of the gaseous hydrocarbons is deposited on the surface of the heated mass; such carbon cannot itself be activated, and it likewise prevents the efficient activation of the batch by forming a protective coating over it. The average carbonisation temperature is about 480 deg. Cent. for the first three hours or so, during which period the bulk of the volatile matter is expelled. The temperature is then increased slowly up to 700 deg. to 750 deg. Cent., which is maintained for about two hours. Control of the carbonisation process is facilitated when the coal is low in volatile matter, for when a high proportion of this is present, the process is either unduly prolonged, or a temperature must be employed which often results in the cracking of the gases.

Usually, when bituminous coal is carbonised alone or in admixture with only a small proportion of anthracite, a special type of retort must be used, owing to the high proportion of tar produced, which would spoil the product for activation purposes. The object of such a retort is to convert the tar into volatile constituents, which are then expelled as such. Briquettes are loaded into the retort at the top in the usual manner, but there are two distinct air currents within the retort. The upper part has a downward draught, and the lower part an upward draught, created by an exhaust fan. When tar forms in the upper portion of the charge, it is drawn downwards into the hotter part of the retort and decomposed by the heat. The gases so formed are driven out at the side of the retort, steam being sometimes used in addition to the air current to form water-gas. In large installations it is often practicable to recover the volatile constituents as by-products; but in smaller plants they may be burned to supply heat to the retorts, or for the ensuing activation process.

With the object of economising in the heating of the retorts, one type of German plant makes use of a series of copper bars interspersed at suitable distances in the charge in the vessel. These copper conductors, which dip into the furnace beneath the retort, and are protected from the direct action of the fire by firebrick, act as conductors of heat from the furnace to the interior of the batch, and thus ensure a uniform heat distribution.

Activation.

When carbonised, the material is allowed to cool; then it is ground and sifted to produce a finely divided powder. Such a powder possesses little, if any, capacity for the adsorption of gases, colour particles, &c. It is therefore said to be inactive. To activate it, use may be made of a number of chemicals, such as acids, alkalies, and various salts. The application of such substances to this purpose has formed the subject of numerous patent specifications in the past. Activation may also be accomplished by the use of a gas, such as hydrogen, or by steam. When steam is the activating medium the carbonised material in general need not be so finely ground in order to attain the required degree of activity. Steam activation has also the advantage of being cheaper than the majority of the other methods.

The temperature of activation generally ranges from 900 deg to 950 deg. Cent., depending on the quality of the carbonised material. Vertical retorts are mostly used on the Continent for the process of activation, and it is usually necessary for some form of stirring gear to be introduced into the vessel; or the process may be made continuous and the stirrer dispensed with, in which case raw carbonised material is gradually fed into the head of the retort, while the activated carbon is continuously removed at the base. In some types of retorts the steam nozzles, through which superheated steam is blown, are so arranged as to keep the charge in the retort in constant motion by the movement of the steam current. A vertical retort working on the non-continuous principle and providing for no movement of the material during steam treatment, invariably gives poor results, for the steam has the greater effect on that portion of material nearest the nozzles, whilst the interior of the batch is scarcely affected.

At the commencement of activation the raw carbonised material in the retort may be regarded as a mixture of amorphous carbon and hydro carbons. To render the material active, the hydro carbons must be oxidised by the oxygen from the steam and removed as gases. Best results are invariably obtained when a rapid oxidation of the hydro carbons occurs (ensured by adequate movement of the batch during steaming), but only a very slow oxidation of the amorphous carbon (obtained by careful temperature regulation). The gases resulting from the process, which are led off at the head of the retort, contain a large proportion of water gas mixed with uncombined gases. Analysis of these gases from different processes shows them to vary within a wide range, viz., CO_2, from 4 to 25 per cent.; CO, from 12 to 42 per cent.; and H_2, from 52 to 63 per cent. The composition of the gases in any specific case will depend largely on the type of raw material in use, and the degree of carbonisation; as also upon the temperature and proportion of steam used. This mixture of gases, in which hydrogen predominates, may be utilised in the hydrogenation of the tar from the carbonisation process. Such hydrogenation produces motor fuel oils, ammonia, and gases of high calorific value, which gases may be added to the ordinary coal gas resulting from the carbonisation, and so enrich the latter. Normally, the period of steaming in the activation process is from three to six hours, the degree of activation being governed mainly by the degree of homogeneity of the material. For gas adsorption purposes the carbon, when cooled, may be used in the condition in which it leaves the retorts. For in these cases a very finely divided material is not required. But for decolorisation purposes, &c., a specially fine material is required. so that a further grinding and screening operation, to eliminate caked material and to give a uniform particle size, is necessary to such carbons.

Evaluation.

Much research work has been carried out in an endeavour to find a standard system of evaluating activated carbons, resulting in a multitudinous collection of methods for the determination of their adsorption capacity. This quantity may be given either as "weight activity," which is a measure of the weight of adsorbed substance taken up by 100 grammes of the carbon, or by "volume activity," when 100 c.c. of carbon are substituted for 100 grammes. A known quantity of carbon is well mixed with a liquid, during which certain constituents are adsorbed; the carbon is then separated by filtration, and tests carried out on the filtrate for the amount of material adsorbed. The adsorption of colour from a standard caramel solution or from a standard iodine solution is used frequently as a test of the decolorising capacity. But the amount of colour taken up by a carbon from such solutions will be largely influenced by the *p*H value of the mixture, and to some extent by the method adopted in activating the carbon; also by its particle size, although diminution of the particle size of activated carbon does not always increase the adsoptive capacity for colouring matters. Use has also been made of the propensity of carbon to adsorb gases and vapours, and whilst, indubitably, this is an excellent method of evaluating gas adsorbent carbons, the results obtained cannot readily be translated into terms of decolorising power, and usually form no criterion as to the value of the carbon as a decolorant.

Significance of *p* H (Hydrogen Ion Concentration) Values.

Intimately associated with the adaptability of a carbon for a specific purpose is the active acidity or alkalinity derived from the non-carbon content. Normally, a carbon prepared from coal is an acid carbon; alkaline properties may be imparted to it, when necessary, by mixing in a small proportion of lime or other alkali before activating. The hydrogen ion concentration of a water extract from the carbon usually gives a good indication of its suitability for a particular purpose. A carbon in which, when in water, the positively charged H ions exceed those of the negatively charged O H ions, is generally a good decoloriser. For since the majority of colouring matter to be adsorbed from commercial liquids is negatively charged, it follows that the higher the concentration of H ions the greater will be the attraction for the oppositely charged colouring matter. However, in some industries there are other factors to be considered, and which often militate against the use of a carbon with a low *p* H.

For example, in the decolorisation of glucose liquors, a *p* H between 5 and 6 is preferable, since this is found to be the most favourable ionic concentration for the adsorption of the amphoteric protein colouring matter which is always present in these liquors, and at this *p* H the bulk of the other colouring matter is also adsorbed. But at a *p* H below 5 or higher than 6, most of the discoloration due to proteins would remain in the liquor after carbon treatment. In the decolorisation of cane sugar liquors, a low *p* H carbon is not permissible, although this type of carbon would be an excellent decoloriser; since the acidic nature of a carbon with a *p* H below 7 would be definitely disadvantageous in contact with sugar liquors, causing considerable loss by inversion of sugar. Conversely, in the decolorising of oils and fats, a low *p* H carbon—about 4·5 to 5·5—is preverable, for a carbon with a *p* H of 7·5 or more, in addition to being an inefficient decolorant, would give rise to soap formation during processing.

To determine approximately the *p* H value of a carbon, 25 grammes of the carbon are boiled with 500 c.c. of distilled water for one hour. The boiling should be carried on under a reflux condenser, or, if in an open vessel, the water lost by evaporation should be replaced; 10 c.c. of the cooled mixture is then filtered, and two drops of B.D.H. universal indicator added. From the colour so produced, and with the aid of the colour scale supplied by British Drug Houses, Ltd., London, the approximate *p* H value is ascertained.

Activated Carbon in Gas Treatment.

As long ago as 1879 an American process for the purification of coal gas with bone charcoal was protected—U.S. Patent No. 209,698—in which the char was first mixed with a small proportion of tar and the mixture then transferred to one or more containers serving as purifiers. In recent years the development of activated carbon—a material consisting chiefly of carbon itself, the surface of which has been specially treated to increase its capacity for adsorption—has led to this more efficient product, entirely replacing charcoal for gas treatment. It is now generally acknowledged that, in addition to acting as an adsorbent, activated carbon, in many cases, exerts a certain catalytic action on crude gases, which property further enhances its value.

Desulphurising of Gas.

In removing the hydrogen sulphide from coal gas, the latter is first diluted with from 1 to 2 per cent. of air. The oxygen of this added air oxidises the H_2S in the gas to water and sulphur, which are then taken up by the carbon. Incidentally, a current of steam may be used in admixture with the crude gas instead of air. One method, recently developed in Germany, consists of first separating the tar and benzol from the gas by the usual methods. The gas, in admixture with air or steam, is then led first through a cooler to condense remaining vapours, followed by passage through a preliminary filter column of wood meal to arrest residual entrained vapours. It next proceeds into a series of carbon purifying columns, arranged in two sets, one of which is in use while the other is being exhausted of its adsorbed sulphur. The latter, which is precipitated on the carbon, may be removed either by roasting or steaming, or, more conveniently, by extraction with a solvent. It is generally found that the presence of a little ammonia in the gas is of advantage, for the ammonium hydrosulphide, formed from the NH_3 and H_2S, is more easily oxidised than H_2S itself, the equations being as follows:—

$$4\,NH_4SH + O_2 = 2\,(NH_4)_2S_2 + 2\,H_2O.$$
$$2\,(NH_4)_2S_2 + 3\,O_2 = 2\,(HN_4)_2S_2O_3.$$

The decomposition of the resulting thiosulphate with the concomitant adsorption of its sulphur on the carbon proceeds practically to completion. In desulphurising, the affinity of the carbon for the sulphur is very high. The gas can, accordingly, be passed through the carbon columns at a relatively high speed without leaving any trace of sulphur in the treated gas.

With the carbons produced by the British Carbo-Union the adsorption capacity is between 25 lb. to 50 lb. of sulphur per cubic foot of carbon, and in their plants the adsorbed sulphur is extracted with ammonium sulphide solution, either at ordinary temperatures or with slight heating. The sulphur goes into solution as polysulphide, and when extraction is complete the carbon still retains the ammonium sulphide solution, which is afterwards removed by steaming out the carbon. This steaming process results in the regeneration of the carbon, and its activity is practically restored to its original value, whilst the ammonium sulphide recovered from the steaming process may also be reused. The sulphur is recovered from the polysulphide solution by simply boiling the latter, when the sulphur is precipitated and ammonia with hydrogen sulphide formed. These pass over with the steam leaving the sulphur in granular form in admixture with water. If the boiling of the polysulphide is carried out at a temperature above the melting point of sulphur, liquid sulphur is obtained, which can be worked up as roll or lump sulphur as desired. The sulphur thus recovered is pure and equal in quality to the refined Sicilian or American product.

Carbon Regeneration.

It is well known that one of the most common methods of revivifying active carbon involves a calcination process; but in the case of carbon that has been in prolonged contact with coal gas, traces of benzol and similar hydrocarbons are nearly always present. In such cases calcination of the used carbon is not recommended, for the residual benzol is converted to a crude soot containing an appreciable proportion of hydrogen, which can be removed only by oxidation processes at temperatures of 900 deg. to 950 deg. Cent. This benzol soot has little or no adsorptive power, and even when activated by the usual processes does not attain more than 50 per cent. of the normal activity of a new carbon. The purifying action of carbon for gases is shown by several investigators to be enhanced by washing the carbon with hot water before regenerating. In cases where the customary steaming or washing procedure does not eliminate impurities from the carbon sufficiently, they may often be expelled and recovered by vacuum distillation at elevated temperatures.

A Large Planer and a Boring Mill.

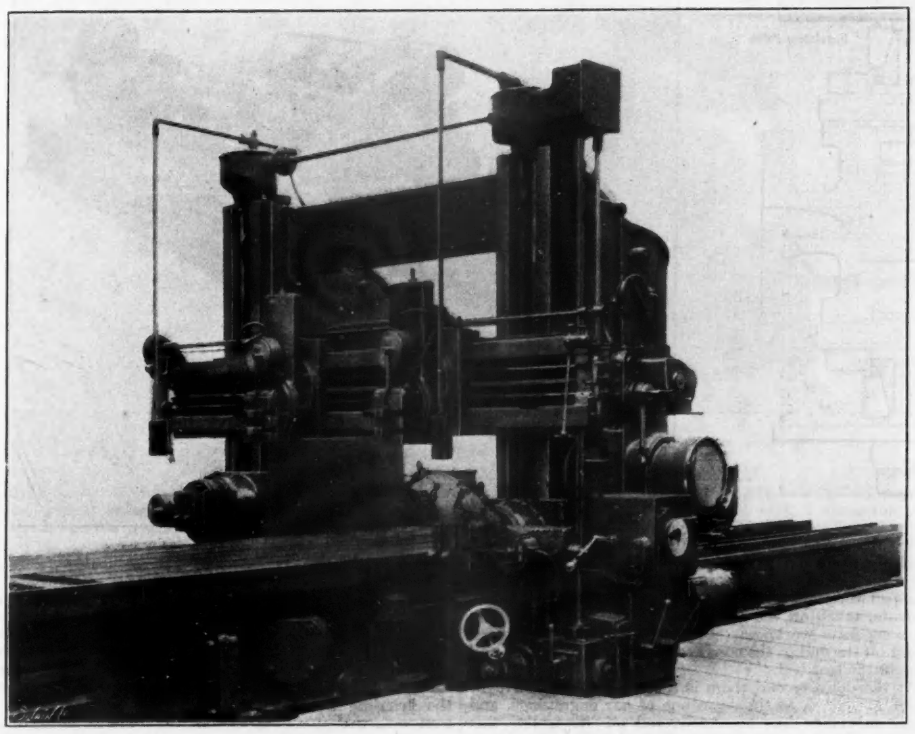
BOTH the machines illustrated in the accompanying engravings were made by Craven Brothers (Manchester), Ltd., of Reddish, Stockport. The planer is fitted with four tool-boxes and will machine work up to 6ft. 3in. wide by 5ft. high with a length of 11ft. or 22ft., according to whether one table alone or both together are used. The tool-boxes on the slide have automatic feed motions for horizontal, vertical, and angular cuts, and are provided with double swivel motion so that standard tools can be presented at a suitable angle to the work and special tools are rendered unnecessary. These boxes can be fed or quick traversed in the same or opposite directions. In construction the side tool-boxes are similar to the others, but they have automatic feed in the vertical direction only. Horizontal and angular feeds are obtained by hand. A counterpoise for each side tool box hangs within the column. All the boxes are equipped with the "Craven" patented electro-magnetic tool lift, which raises the tools from the work on the return stroke of the table. The device will operate at any angular position of the tool slide over 180 deg. As the electric supply is fed to each box through a plug and socket connection it can easily be rendered inoperative for each individual box if required. The magnetic tool lifting device has insufficient movement to enable the tool to be lifted clear when cutting tee slots. For use when a machining operation of this nature is being carried out the arrangement of shaft, hand lever, and chains, clearly to be seen in the engraving, is used by the man in charge.

The table is driven by a machine-cut spiral pinion, forged solid with its shaft, gearing into a rack of hard cast iron bolted and keyed to the underside of the table. The makers state that at least four teeth are always simultaneously in engagement with the rack, so that the table is driven with great smoothness. The spiral pinion runs in oil and the thrust is taken by heavy ball bearings. Totally enclosed spiral gearing transmits the power from the 40 h.p. "Lancashire" planer equipment to the spiral pinion. Cutting speeds available range from 40ft. to 180ft. per minute and return speeds from 120ft. to 220ft. per minute. Reversal of the table and operation of the feed gear is controlled from the dial mechanism to be seen in the engraving.

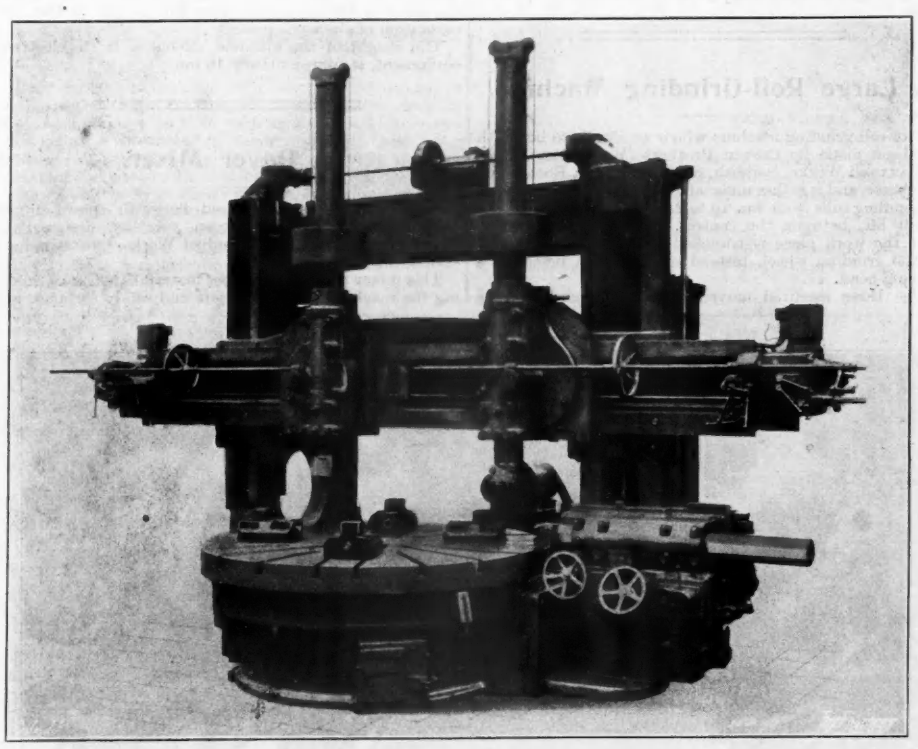
A separate 5 h.p. motor, which is also utilised for the quick traverse motions, for raising and lowering the cross slide, and for the milling feed traverse, operates the feed gear. The setting on the feed dial fixes the number of revolutions of the feed motor. Feeds available on the cross slide range from $^1/_{64}$in. to $\frac{3}{8}$in. horizontally and from $^1/_{128}$in. to $\frac{3}{8}$in. vertically. The vertical feeds on the side tool-boxes have the same range as the horizontal feeds on the cross slide.

Two pendant switches have each eight push buttons for start, stop, inch forward, inch reverse, feed on, feed off, traverse forward, and traverse reverse respectively. The power traverse motion is so arranged that, in addition to the normal traverse speed, an extra speed of about $\frac{1}{4}$in. per minute is provided for milling purposes. This speed is obtained by the use of extra gearing in the feed mechanism brought into operation by means of a clutch.

The general design of the other machine—a 10ft. vertical boring and turning mill—is easily observed in the engraving. It has a table 9ft. in diameter driven by external spur gear and will swing between the uprights 10ft. 1in. The height admitted under the tool holders is 6ft. The table track is of V section and is lubricated under pressure by an oil pump which feeds only when the table is rotating. Four detachable jaws are mountable on the table. The cross slide is adjustable vertically on the uprights through the medium of an auxiliary reversing motor mounted on the top brace of the machine. Each saddle is provided with a steel octagonal ram with a vertical travel of 4ft. and is arranged to have self-acting feeds horizontally, vertically, and angularly and power traverses in each direction. Both slides will swivel 45 deg. to either side of the vertical. Each head has an independent feed motion. A side head is fitted on the right-hand upright. The gear-boxes for the various motions give twelve table speeds from 0·64 to 13·48 r.p.m., and six feed changes ranging from 0·013in. to 0·75in. per revolution of the table for the vertical heads. The side head has also six feed changes ranging from $^1/_{32}$in. to $\frac{1}{4}$in. vertically and from $^1/_{64}$in. to $\frac{1}{8}$in. horizontally. The main driving motor of the machine is of 40 h.p. and runs at 960 r.p.m., and there is a 5 h.p. elevating motor and two quick traverse $2\frac{1}{2}$ h.p. motors.



LARGE DOUBLE TABLE PLANER

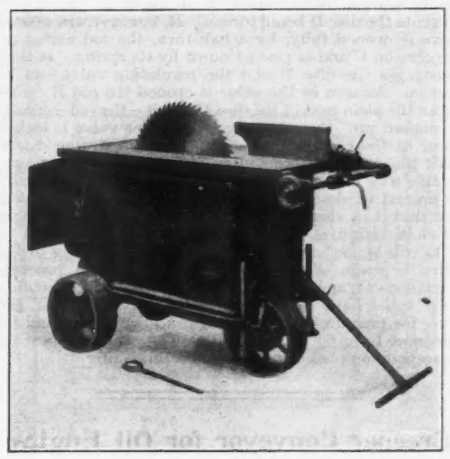


10-FOOT VERTICAL BORING AND TURNING MILL

A Portable Electric Saw Bench.

THE portable electric saw bench shown in the accompanying illustration has been brought to our notice by Wright (Electric Power Specialists), Ltd., Century Works, Halifax. It has been specially designed for the use of timber merchants, cabinet makers, builders, &c., who have access to an electric supply. The bench is carried on a three-wheeled bogie with broad flanged wheels suitable for soft ground, and two ramp pins serve to steady the forward end when the saw is in use. All the wheels can be wedged if necessary. The saw spindle runs in ball bearings, and is dynamically balanced to enable it to run at high speeds without vibration. The machined table is fitted with a loose gap plate and an adjustable canting fence graduated for bevel cutting and provided with a fine adjusting hand wheel, while a rule stamped into the table serves for setting the fence for any given width of cut.

The standard driving equipment consists of a 400–440-volt, 50-cycle, ball-bearing, squirrel-cage motor, mounted at the back of the machine and driving the saw spindle through a "vee" belt. An air break starter with no-volt and overload releases serves for starting or protecting the motor, which is supplied with current through a length of four-core cab-tire cable and a four-pin screwed plug. Benches are made to take 22in., 26in., and 30in. saws, and are driven by motors of 6, 7, and 8 h.p. respectively.



PORTABLE ELECTRIC SAW BENCH

A Fluid-Tight Drain Valve.

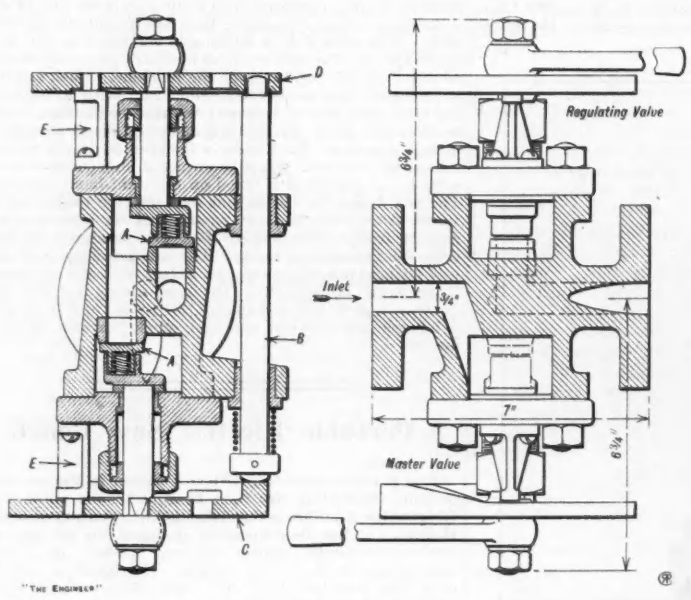
A NEW style of valve for such purposes as the drainage of steam ranges has just been brought out by Hopkinsons, Ltd., of Huddersfield, and is illustrated by the accompanying sectional drawings.

The object aimed at has been to produce a valve that can be left just "cracked" off its seat to allow a mere trickle to pass, a condition which must inevitably damage the valve and seating on account of the high velocity of the passing fluid, but can yet be shut off completely should the occasion arise, even after long service. These requirements have been met by embodying two valves in one casing. One of the valves is normally left wide open, and the other is used to regulate the flow, so that the master valve does not suffer from the cutting action of the steam and can be relied upon to close the passage completely. Both the valves, A A, are of the standard Hopkinson sliding type, in which a Platnam valve is pressed on to its seating by a light spring, and also by the steam pressure. It is opened by being moved sideways by an excentric motion. A half-turn of the spindle is enough to open it fully.

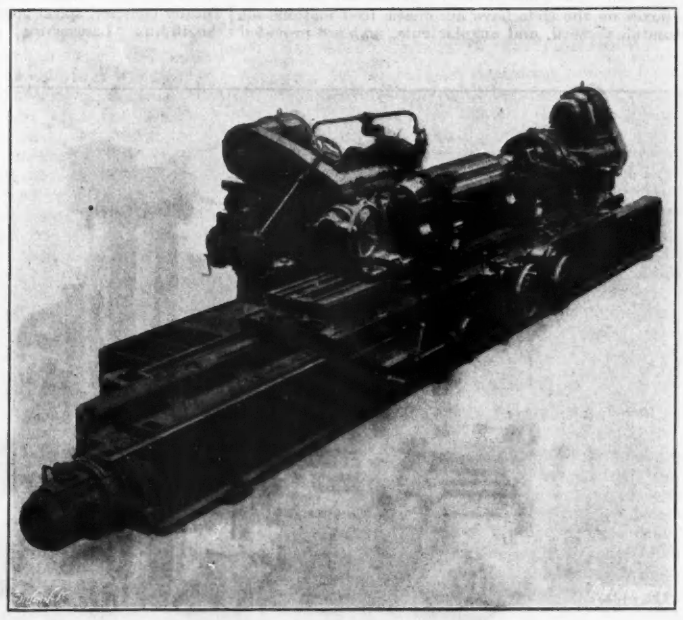
In order to guard against the master valve being damaged by wire-drawing, it is so interconnected with the regulating valve that the two must be worked in sequence.

This interconnection is effected by a sliding rod B and discs C and D attached to the spindles of the two valves. The disc C has a cam-shaped rim, extending halfway round its circumference, on to which the rod B is pressed by a spring. The top end of the rod fits into a hole in the disc D. There are stops E E, which engage in semi-circular slots in the discs and prevent their being turned the wrong way. With the parts in the positions shown the regulating valve cannot be opened, as the rod B prevents the disc D being turned. If, however, the master valve is opened fully, by a half-turn, the rod comes off the cam on C and is pushed down by its spring. It then disengages the disc D and the regulating valve can be opened. As soon as the valve is opened the rod B comes under the plain part of the disc D and it—the rod—cannot be pushed up. Consequently, the master valve is locked open, as the rod cannot ride up the cam on the disc C until the disc D is brought back to the position shown. In this way it is assured that the master valve can only be opened or closed when the regulating valve is closed, and that it is, consequently, saved from wear that might affect its tightness.

As will be gathered from the drawing, the body of the valve is made of a single forging, with the passages machined out, and it is generally of a substantial character. Four types have so far been standardised, two of ¾in. bore, for pressures up to 600 lb. per square inch, and for pressures from 600 lb. to 900 lb. The other two are for corresponding pressures, but have a 1in. bore.



FLUID-TIGHT DRAIN VALVE



LARGE ROLL GRINDING MACHINE

Creeper Conveyor for Oil Engine Erection.

THE principle of assembling standard machinery made on mass-production lines on a steadily progressing conveyor has been developed at the Yeovil works of Petters, Ltd., to embrace two groups of oil engines—those up to 6 h.p. and the others up to 15 h.p. Each group is confined to a separate conveyor.

We are not here concerned with the manufacture of the individual parts of the engines, and it will be sufficient to say that they are collected in groups on to benches which run at right angles to the erection conveyor. The conveyor for the smaller sizes of engines is 100ft. long and has a track of 2in. by 2in. angle iron set on trestles about 18in. above floor level. Four-wheeled trollies run on these angles, and one is devoted to each engine to be erected. Down the centre of the track there lies a channel iron, and in it runs the creeper chain. This chain is driven through double-reduction gearing by a 25 h.p. electric motor at a speed of about 6in. per minute, but this speed can be varied to some extent by a regulator on the motor starter. The chain is equipped with dogs at suitable intervals to push the trollies along.

At the driving end of the conveyor the bed-plate and cylinder casting of an engine are placed on a trolley and clamped down, and then, as it progresses, the various components, taken off the adjacent benches, are added, each by a separate workman. Finally, the completed engine is run off the end of the conveyor on to a set of rollers and thus to the test bed.

At the delivery end there is a section of the conveyor which is hinged, as shown in one of our engravings, and when an engine has been delivered off its trolley this section is let down and the trolley placed on the lower part of the conveyor track. It is then dragged back to the starting point by the return strand of the creeper chain.

The conveyor for the larger engines is, naturally, more heavily built, and is 70ft. long. In this case the completed engines are picked up by an electric crane and put on trucks running on rails let into the floor for conveyance to the test beds. The empty erecting trollies are lowered on to the return track by a hydraulic lift, while another lift raises them again at the starting end. It is said that the cost of the upkeep of these conveyors is practically negligible, and that they have both speeded up production and reduced the cluttering up of the floor with component parts.

A Large Roll-Grinding Machine.

THE roll grinding machine which we illustrate herewith has been made by Craven Brothers (Manchester), Ltd., of Vauxhall Works, Reddish, Stockport, for a Rotherham purchaser, and is rather unusual in its design. It is capable of handling rolls from 3in. up to 24in. in diameter, and will admit 8ft. between the centres. It has the peculiarity that the work piece is travelled axially across the face of the grinding wheel, instead of the wheel being on a moving head.

The three essential movements of the machine—the driving of the grinding wheel, the rotation of the work piece, and its axial travel—are each driven by their independent electric motors. The grinding wheel, which is 22in. in diameter by 2½in. wide, is driven through Texropes by a 15 h.p. motor, the work piece is rotated by a 7½ h.p. motor, and the table is travelled by a 5 h.p. motor. There is also a 2 h.p. motor for driving the coolant circulating pump.

The main bed of the machine, it will be seen, has one V slideway and one flat slide, on which the two heads carrying the roll to be ground slide. The two heads are mounted on separate bases, so that they can be set at an angle to the direction of travel for turning tapers. This adjustment is effected by screws and hand wheels which are readily accessible. For grinding a parallel roll indicator gauges are provided, and there is also an arrangement for grinding them with either convex or concave contours. This result is produced by the transverse movement of the grinding head, which is interconnected through a cam with the travelling mechanism. The grinding head can, of course, be set by hand to regulate the depth of the cut and to accommodate the wear of the wheel. A mirror is so arranged that the operator can easily see the approach of the wheel to the roll, and a diamond trueing device is fitted. The grinding wheel spindle runs in adjustable pump-lubricated bearings fitted with sight feeds, and can be driven at a speed appropriate to the material being ground and the diameter of the wheel. The spindle itself is 4½in. in diameter.

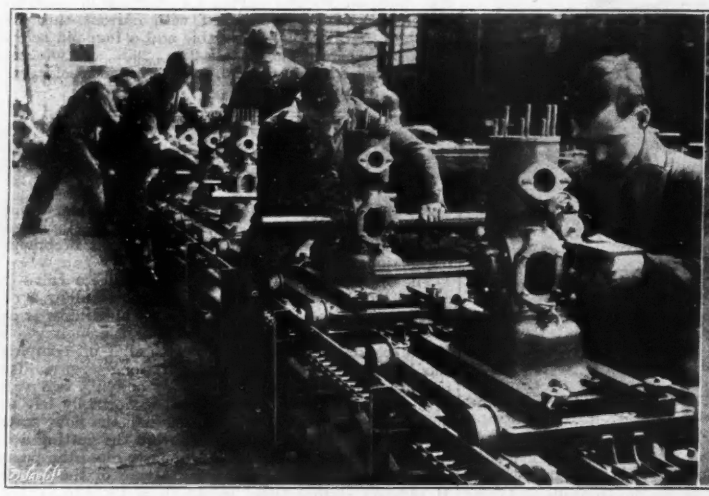
The weight of the roll to be ground is carried by pad bearings, in which it is steadied by adjustable back rests. It runs between centres and is driven by a floating chuck with two jaws that engages with its wobbler end. Six speeds of rotation, from 6 to 42 r.p.m., are provided, and the speed of travel can be either ⅛in. to ⅛in. or 1¼in. per revolution of the work piece.

The weight of the machine, exclusive of the electrical equipment, is approximately 16 tons.

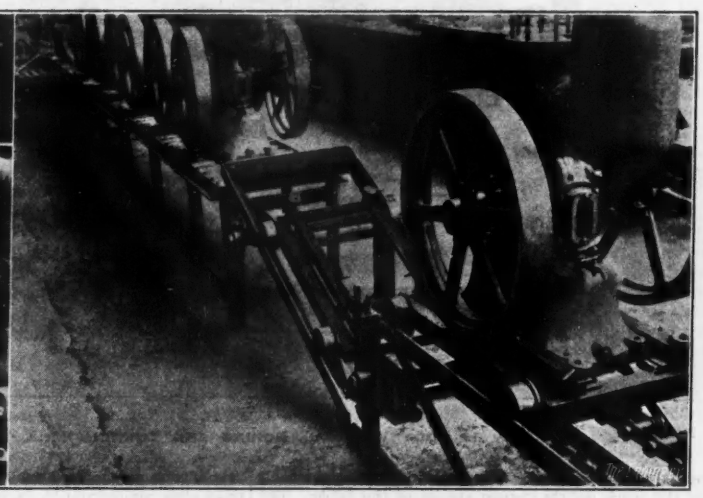
A Paver Mixer.

THE photograph reproduced herewith shows a new paver mixer, which has been specially designed by Frederick Parker, Ltd., of Viaduct Works, Leicester, for a contractor in the Near East.

This mixer travels on creeper (caterpillar) tracks, enabling the machine to traverse soft and sandy surfaces, and is self-propelling. It can travel in the forward and backward directions at two speeds of approximately 1½ and ⅝ miles per hour. It will be observed that the mixer is equipped with a power loader to raise the material from

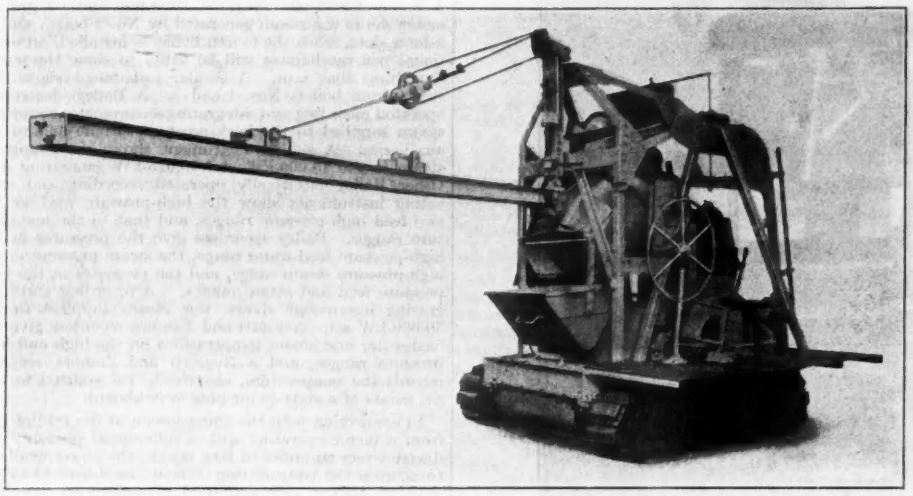


CREEPER CONVEYOR FOR OIL ENGINE ERECTION



DELIVERY END OF CONVEYOR

the ground level to the mixing drum. The mixer is of the open drum tilting type, fed by the power loader. Its rated capacity is 10 cubic feet of unmixed material per batch, or 7 cubic feet mixed material per batch, and it is capable of dealing with approximately 70–90 cubic yards per eight-hour day under normal conditions. The drum can easily be tilted by a large hand wheel and gearing, and there is also a conveniently situated single lever for



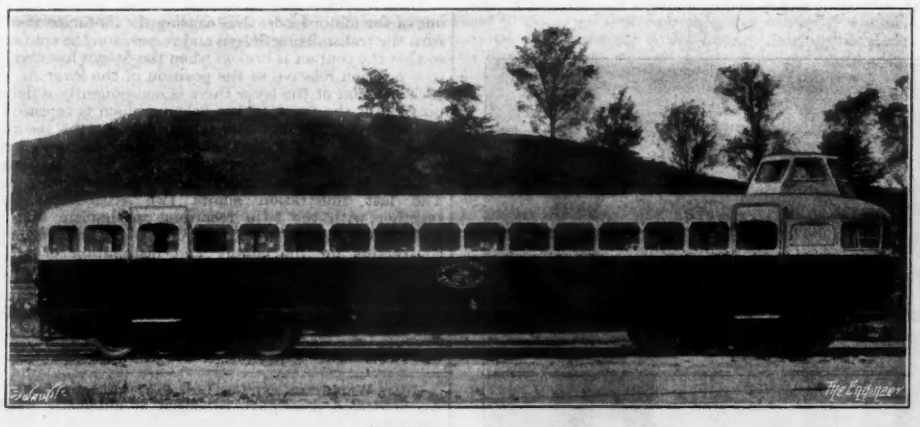
OIL ENGINE-DRIVEN PAVER MIXER

controlling the clutch and brake. Over the mixing drum an automatic measuring water tank is provided to feed the drum in the mixing position, and an adjustable ball valve regulates the quantity in the tank, which is indicated by a scale on the side of the tank. The plant is driven by a "Petter" oil engine of 10 h.p.

The concrete is discharged from the mixing drum into a receiving hopper, which is hand propelled along a swivelling boom. The boom has a radius of 17ft. 6in., although it has been made in sections, so that when necessary it can be shortened for dealing with smaller radii. All the controls are localised, so that one man on the seat platform has full control over the travelling of the machine, the operation of the mixing drum, power loader, and water tank. Steering is effected by an arrangement of dog clutches and sprags, whereby either side creeper track is simultaneously disengaged from the drive and braked so that the machine as a whole turns about the stationary track. A pedal-operated multiple disc dry plate clutch is provided for easy and immediate disengagement. An interesting feature is that specially prepared hard wood pads have been provided for the creeper track, to be fitted when it is desired to move the machine under its own power along first-class roads that might otherwise be damaged.

A Railcar with Pneumatic Tires.

LAST Monday, February 18th, we took advantage of an invitation from the London, Midland and Scottish Railway Company to take part in a demonstration run on a railcar with which, in conjunction with Armstrong Siddeley Motors, Ltd., the company is shortly to carry out extended trials. The vehicle is of the Michelin type mounted on two eight-wheeled bogies, each wheel of which is fitted with pneumatic tires. Similar cars are, we understand, to be built in this country, and will be termed Coventry Pneumatic railcars. The particular coach utilised for the demonstration was of French manufacture,



RAILCAR WITH PNEUMATIC TIRES

and besides a roomy luggage compartment, provided accommodation for fifty-six passengers. It left Euston with a nearly full complement at 10.10 a.m.

On the outward journey it made stops at both Willesden and Watford in order to demonstrate its accelerative and braking capacities. Leaving Euston, the climb to the first mile post up the Camden Bank, mostly at 1 in 70, was accomplished in 2 min. 16 sec., and the stop at Willesden Junction, 5¼ miles from the start, was effected in 7¼ min. Leaving Willesden, a speed of 62 m.p.h. was attained within little over a mile of the start, and the 12 miles to Watford were covered in 13¼ min. At Watford, the car was stopped dead in 9 sec. from a speed of over 55 m.p.h.

Proceeding to Leighton Buzzard, the 22¾ miles were covered in 25 min. start-to-stop, at an average speed of over 54 m.p.h., the highest speed attained being 67 m.p.h. The return journey was made without stop, the 40¼ miles being covered in 42½ min. (57·8 m.p.h.) against a strong head wind, and with a slack for permanent way operations near Leighton. The highest speed attained on the return journey was 65 m.p.h.

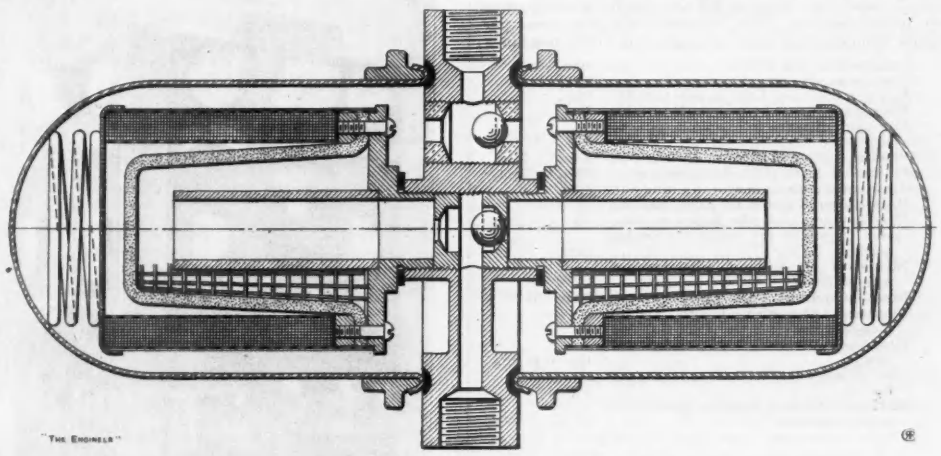
We found the railcar remarkably smooth and silent in running, and its braking capacity is far beyond the capabilities of most railway vehicles. The driver stands on a casing over the engine at one end of the car, and, as will be seen from the accompanying engraving, has a view of the track in both directions from a "conning tower." A 240 b.h.p. engine drives the vehicle, which has an unloaded weight of about 8 tons 5 cwt., and a useful load of 5 tons. The power-to-weight ratio is, therefore, high, and the useful load amounts to as much as 60 per cent. of the tare weight. It is as a result of the shock-absorbing qualities of the 36in. pneumatic tires, so it is claimed, that so light a frame and body can be fitted. The maximum speed is in the neighbourhood of 70 m.p.h., and the cruising speed 55 to 60 m.p.h. On account of the rapid acceleration and braking that are possible, the vehicle is capable of maintaining a very fast schedule even on a service involving frequent stops. It is also claimed that railcars of this type could be safely run "on sight."

A New Gland Packing.

A NEW form of gland packing for valve stems, pump rods, and so forth, which has just been brought out by Richard Klinger, Ltd., of 120, Southwark-street, London, S.E.1, is made up in the form of a loose fibrous mass. The chief ingredients are specially prepared asbestos fibre and very fine colloidal graphite. It will thus be seen that it is eminently suited for high-temperature work. It is also resistant to attack by oils, spirits, and hydro-carbons. Tests spread over the last five years have proved that the old practice of making the stuffing-box and gland with bevelled ends is not satisfactory, as the packing tends to squeeze out, and there is an uneven distribution of pressure. The makers recommend square ends, and, in the case of existing boxes with bevelled bottoms, the insertion of a specially fitted bottoming ring to provide a square face. The box should be filled with the fibre packing and the gland squeezed down as hard as possible. The space should then be filled up with more packing and the gland tightened down again. As the packing does not expand appreciably under the action of heat, it is not necessary to slack back the gland to any great extent after packing. Messrs. Klinger say that they will be pleased to send a sample of the packing to engineers so that they can make a practical test.

A New Oil Filter.

THE oil filter illustrated by the accompanying line drawing is one of several which have been recently evolved by C. G. Vokes, Ltd., of 95, Lower Richmond-road, Putney, London, S.W.15, for the fuel or lubricating oil of internal combustion engines. Most of the parts are standardised die castings or stampings, but the filtering medium is chosen to suit the working conditions. In the case illustrated, there is first a fine wire gauze, then a layer of Protectomotor fabric, which has been described in THE ENGINEER before, and finally what may be described as a top hat of solid-drawn material. The flow is, of course, from the outside inwards, and the cells are worked alternately, so that one can be cleaned while the other continues



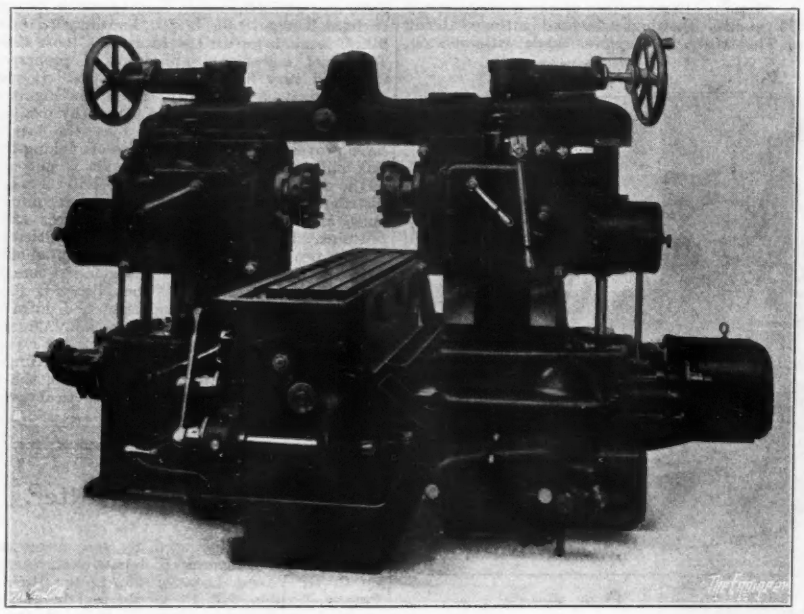
OIL FILTER FOR FUEL OR LUBRICATING OIL

service. For this purpose it is only necessary to loosen the banjo connections and turn the filter through 180 deg., when the new element comes into operation.

Heavy Duty Milling Machine.

THE tool illustrated is made by Alfred Herbert, Ltd., of Coventry, both as a single head machine and as a double head machine. It is intended for the production of milled work in quantity, and has sufficient power and strength for heavy duty. As it has been given wide ranges of speeds and feeds, it can be used with large or small cutters on non-ferrous metals, besides iron and steel. The two heads are similar in design. Both are driven from a high-speed flanged motor bolted on the right-hand side of the machine to the clutch box. The main driving shaft in this box has an extension running along the back of the bed, which drives the left-hand spindle head through spiral bevel gears. We need not refer in detail to the design of the bed, columns and spindle heads, since the photograph reproduced gives an adequate impression of the sturdiness of the structure. The spindle heads are raised by screw and nut mechanisms, through bevel gears and large hand wheels on horizontal shafts. Four clamping bolts, with their nuts accessibly placed on the front side, hold each head firmly. The gearing in the spindle head is driven by a vertical splined shaft from the clutch box through a multiple start worm and worm gear and pick-off gears carried in a casing bolted to the spindle head. These pick-off gears have a safety device by which the door of the casing in which they work cannot be opened until the clutch connecting the bevel gears at the bottom of the vertical shaft is disengaged. The feed box is bolted to the front face of the base. It contains the mechanism for the feed and quick table motions, and also the continuously rotating double helical cam by which the main clutch and brake are operated for starting and stopping the spindle automatically. The rate of feed is varied by pick-off gears which run in a casing on the front of the feed box. The automatic cycle of movements which is obtainable with this machine is controlled by dogs clamped in Tee slots on the left-hand edge of the table. Projections on the

vertical trip shaft are engaged by the dogs causing the shaft to rotate and to move axially up and down. The two columns are tied together at their upper ends by a round bar which connects the elevating screw brackets on the tops of the columns. A special overhanging arm is furnished for the right-hand spindle head. It is flanged at its outer end, so that it can be bolted to an arm fixed to the left-hand spindle head to connect the two heads rigidly together. The form of the arms is such that the spindle heads may be set at different heights when the arms are bolted together. The following table gives some particulars and dimensions of the single and duplex machines:

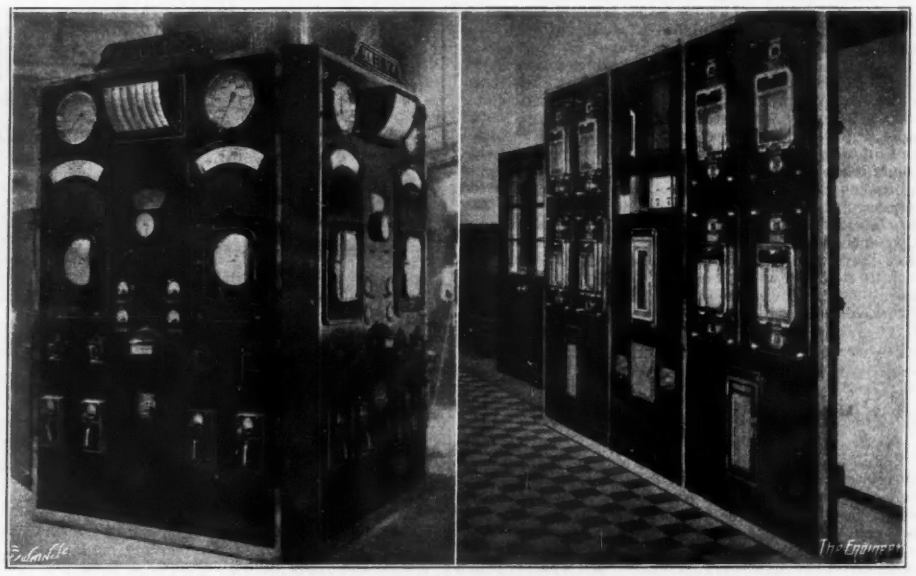


HEAVY-DUTY MILLING MACHINE

Longitudinal feed of table	36in.
Transverse adjustment of column	4in.
Maximum distance from spindle to table	12in.
Minimum distance from spindle to table	3in.
Maximum distance from spindle nose to arm brace	19in.
Working surface of table	57in. by 14in.
Width and depth of overhanging arm	8¾in. by 7½in.
Centre of spindle to arm	6¼in.
Horse-power of motor, for single machine	7½
Horse-power of motor for duplex machine	10
Speed of motor for single or duplex machine, r.p.m.	1420
Number of spindle speeds, with standard pick-off gears	16
Range of spindle speeds, r.p.m.	20 to 761
Number of automatic feeds with standard pick-off gears	18
Range of automatic feeds, inches per minute	1in. to 41¼in.
Rate of quick power motion, inches per minute	150in.
Maximum distance between spindles on duplex machine	22½in.

Boiler Instrument Panels.

In connection with the extensions to the boiler-house plant at the Brighton power station, described in our issue of September 14th, 1934, Allen West and Co., Ltd., of Brighton, supplied the four-sided boiler instrument panel shown in one of the accompanying illustrations. Three sides of the panel carry boiler control instruments for the three new boilers installed, but the fourth side has been fitted with a closing panel, which will be removed and an appropriate panel will take its place when the fourth new boiler is put into service. Eight main instruments are mounted on each panel. There is a Bailey meter for indicating and recording the steam flow and equivalent air flow, a Bailey indicating and recording feed water meter, a Bailey multipointer draught gauge for indicating the draught at several points on the boiler, a Ranarex CO_2 indicating and recording meter, a Negretti and Zambra fifteen-point resistance temperature indicator for showing the temperatures of steam, water and gases, a boiler drum pressure gauge, a feed-water pressure gauge, and a gauge showing the main range pressure. There are also ammeters for the forced and induced draught fan motors, together with controllers for altering the vane positions of the Howden fans and for changing the speed of the fan motors.

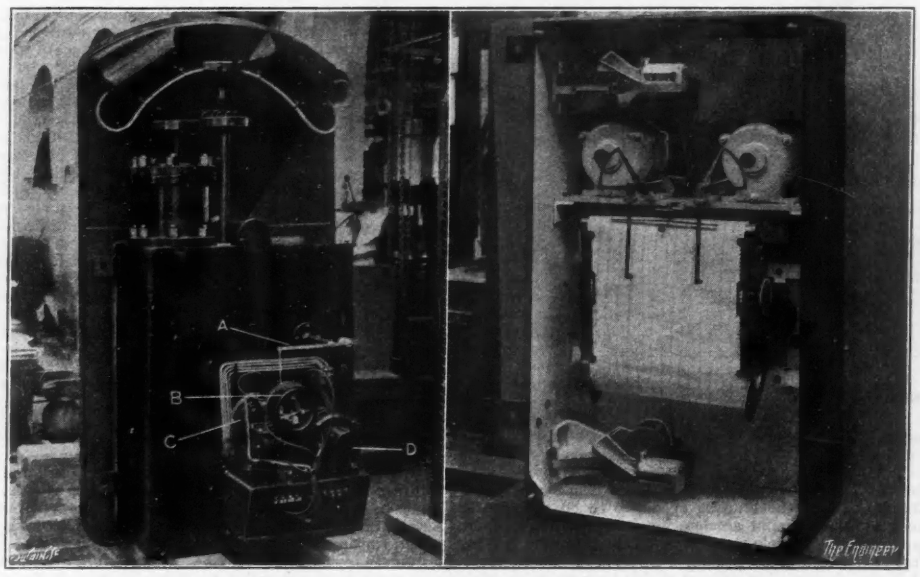


BOILER-HOUSE INSTRUMENT PANEL — CONTROL ROOM INSTRUMENT PANEL

In the control room there is a panel—as shown in another illustration—carrying thirteen boiler instruments. A Bailey electrically operated recording and integrating meter shows the steam generated by No. 2 boiler, and at a later date, when the fourth boiler is installed, an additional pen mechanism will be fitted to show the steam flow from that unit. A similar instrument shows the steam from boilers Nos. 1 and 3. A Bailey electrically operated recording and integrating steam meter shows the steam supplied to the back-pressure turbine and to the auxiliaries. A similar instrument shows the supply of steam to the 15,000-kW and 15,625-kW generating sets. Other Bailey electrically operated recording and indicating instruments show the high-pressure feed to the two feed high-pressure ranges, and that to the low-pressure ranges. Bailey recorders give the pressures in the high-pressure feed-water range, the steam pressure in the high-pressure steam range, and the pressures in the low-pressure feed and steam ranges. A recording and integrating instrument shows the steam supplied to the 30,000-kW set. Negretti and Zambra recorders give the feed-water and steam temperatures on the high and low-pressure ranges, and a Negretti and Zambra recorder records the temperature, electrically transmitted to any six points of a sixty-point plug switchboard.

In connection with the transmission of the rate of flow from a meter operating with a differential pressure produced across an orifice or flow nozzle, the power available to operate the transmitting Selsyn—as described in our issue of August 10th and used in connection with this metering installation—is small, particularly at the lower rates of flow, and a torque amplifier is therefore employed. Referring to the illustration below, the lever A mounted on the spindle operated by the Ledoux bell rises and falls with changing rates of flow, and by means of a link operates a lever on the balanced contactor B, which energises one or the other of the fields of the reversing motor C, geared to the transmitting Selsyn D and to a spindle on which an arm carrying the balanced contactor is mounted.

Thus when the lever A moves a circuit is made through one of the motor feeds, thus causing the motor to revolve, turn the transmitting Selsyn and re-position the contactor, so that the contact is broken when the Selsyn has revolved to a position relative to the position of the lever A. For each position of the lever there is consequently a definite position of the transmitting Selsyn, which is repeated on the receiving Selsyn. The latter operates the recording pen and the escapement type integrator through gearing, and the total amount of steam or water which has passed the flow nozzle or orifice is shown on a six-figure counter. The last illustration shows two receiving Selsyns, together with the twin recording mechanism and two integrators. Allen West and Co., Ltd., acted as main contractors for the supply and installation of all the instruments mentioned.



BACK OF FLOW METER — TWIN RECORDER

CATALOGUES.

HEAD, WRIGHTSON AND CO., Ltd., 5, Victoria-street, S.W.1.—An illustrated descriptive catalogue of automatic weighing machines.

L. M. VAN MOPPES AND SONS, 10–14, Charterhouse-street, E.C.1.—A book on the properties, sources, and uses of industrial diamonds.

HOPKINSONS, Ltd., Huddersfield.—Leaflet 3409 on a combined isolating and relief valve for low-pressure vessels; List 3405 of steam traps.

RATEAU ENGINEERS, 28, Russell-square, London, W.C.1.—Leaflet 100 E, describing the "Aeroventilator" compressed air driven turbo-blower.

HACKBRIDGE CONSTRUCTION COMPANY, Ltd., Hersham, Walton-on-Thames.—A loose-leaf binder containing current literature in connection with Hackbridge transformers, current regulators, &c.

Fuel Consumption and Maintenance Costs of Marine Engines.*

THE items affecting a comparison of the different types of propelling machinery are as follows :—

(1) Cost of machinery (referred to later).
(2) Bunkers.
(3) Engine-room staff wages and provisions.
(4) Engine-room stores, lubricating oil, and water.
(5) Boiler, machinery repairs, and survey.

Basing the costs, for example, on a proposed vessel of 15,500 tons displacement, making loaded passages of 5000 miles, with allowance of 15 per cent. surplus bunkers, it is estimated that the vessel will maintain an average speed of 11¾ knots loaded and 13 knots in ballast under all weather conditions. The cargo carried is as follows :—

Machinery.		
(*a*) Diesel	462×10^6	ton/miles per annum
(*b*) Turbine (oil)	446×10^6	,, ,,
(*c*) Steam recip. (oil)	440×10^6	,, ,,
(*d*) Turbine (coal)	431×10^6	,, ,,
(*e*) Steam recip. (coal)	424×10^6	,, ,,

The following costs per annum are considered to be reasonable and are on a comparative basis :—

Machinery.	Boiler and machinery repairs and survey.	Engine stores and water.	Engine-room staff wages and provisions.
	£	£	£
(*a*) Diesel	1400	625	2750
(*b*) Turbine (oil)	1300	474	2550
(*c*) Steam recip. (oil)	1100	500	2350
(*d*) Turbine (coal)	1350	475	3700
(*e*) Steam recip. (coal)	1150	500	3500

As regards cost of bunkers, the fuel prices naturally vary according to trade routes and current market conditions. It is therefore only possible to make a comparison on the basis of fuel prices chosen to show a fair average of bunker prices ruling during the past few years. Certain routes may favour coal and others oil, and conclusions as to the best fuel to use can only be arrived at after consideration of the particular requirements of each case. On this basis, the following figures have been chosen for comparison :—

Furnace fuel oil	35s. per ton
Diesel fuel	45s. ,,
Coal	20s. ,,

The bunkers consumed at sea per annum would therefore cost as follows:—

Machinery.	Fuel lb./s.h.p./hr all purposes	Tons fuel consumed at sea per annum.	Cost per ton.	Cost for 300 days steaming per annum.
			s.	£
(*a*) Diesel	0·360	3,472	45	7,812
(*b*) Turbine (oil)	0·750	7,232	35	12,660
(*c*) Steam recip. (oil)	0·900	8,680	35	15,190
(*d*) Turbine (coal)	1·125	10,848	20	10,848
(*e*) Steam recip. (coal)	1·350	13,020	20	13,020

The costs per million ton/miles can therefore be summarised as follows :—

Machinery.	Boiler and machinery repairs and survey.	Engine stores and water.	Engine room staff wages and provisions	Bunkers
	£	£	£	£
(*a*) Diesel	3·03	1·35	5·96	16·90
(*b*) Turbine (oil)	2·92	1·06	5·70	28·40
(*c*) Steam recip. (oil)	2·50	1·13	5·35	34·42
(*d*) Turbine (coal)	3·13	1·10	8·58	25·30
(*e*) Steam recip. (coal)	2·71	1·18	8·25	30·70

These costs are shown diagrammatically in Fig. 1.

In arriving at the above analysis of costs, the following points have been taken into consideration :—

Engine-room Stores and Water.—The principal item affecting this comparison is lubricating oil. Turbine machinery is the most economical in this respect; the consumption per day being approximately 3½ gallons for turbine, 5 gallons for steam reciprocating, and 12 gallons for Diesel machinery. On the other hand, more fresh water will be required for steam machinery. For Diesel machinery 1½ tons per day has been allowed for make-up feed and cooling water system, and for steam machinery 3 tons for make-up feed, any boiler water above these amounts being supplied by the evaporator.

Engine-room Staff Wages and Provisions.—The costs under this heading include the wages and provisions of the engine-room staff. An electrician has been included in the Diesel and turbine proposals, but not in the case of the steam reciprocating type. The higher scale of pay for motor ship engineers has been included. The coal-fired vessels require six additional firemen and three trimmers, involving extra wages and provisions.

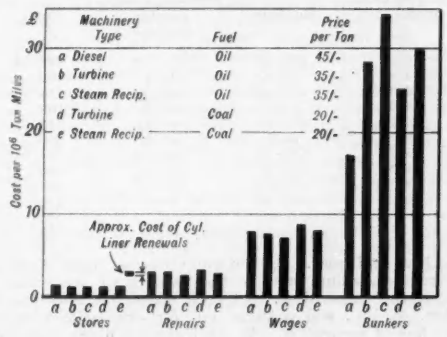
Boiler, Machinery Repairs, and Survey.—These costs are taken to include boiler repairs and cleaning, repairs to main and auxiliary machinery, superheater repairs, examinations and special survey of boilers, machinery and propeller shaft. The costs shown may be, of course, considerably reduced where time and regulations permit of some of the work being done by ship's staff. It may be mentioned that, in this type of vessel, repair costs are likely to be on a higher scale owing to the little time available in port for repairs and examinations and the necessity of frequently bringing in shore assistance.

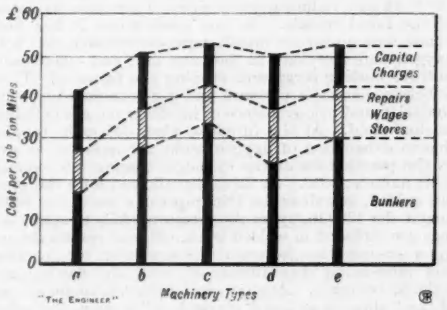
Although cost of repairs to Diesel machinery has fallen considerably due to the gain in experience of the *personnel* in this type of machinery and improved design and facilities for repairs, the repair costs are still somewhat higher than for steam machinery. The costs will vary considerably not only with the type of machinery, but with the care and attention it receives.

Machinery examinations, apart from repairs, form an important proportion of this expense. The following is a list of examinations which may be considered an average for the type of machinery in question.

	Reciprocating engines.	Turbines.	Diesel engines.
Boiler cleaning	¼ year	¼ year	¼ year
Cylinders—			
H.p.	¼ ,,	2 years	1 to 1½ years
M.p.	¼ ,,	2 ,,	
L.p.	¼ ,,	2 ,,	
Main bearings	1 ,,	1½ ,,	1½ ,,
Connecting-rods—			
Top ends	¼ ,,	—	1½ ,,
Bottom ends	½ ,,	—	1½ ,,

Although from this list it would appear that Diesel machinery does not entail much more examination on the whole than other types, it must be remembered that the opening out of cylinders and withdrawal of pistons for examination is a more lengthy and arduous job than with a steam reciprocating engine. Fortunately, there has been considerable improvement in later designs of Diesel machinery to facilitate the dismantling and generally to improve the accessibility for examination and repairs. The removal of a cylinder head in a modern two-stroke





FIGS. 1 AND 2—RUNNING AND MAINTENANCE COSTS AND TOTAL COSTS

engine with airless injection presents little more difficulty than in a steam reciprocating engine, although it must, of course, be remembered that there are generally more cylinders to be examined.

Cylinder liner wear has been the subject of a considerable amount of discussion and still remains an important technical problem. The actual commercial importance may be assessed by considering the liner renewals required in a normal eight-cylinder four-stroke engine of the power under consideration. Assuming that the rate of wear is about 0·005in. per 1000 running hours, the liners will have a life of approximately 50,000 hours. During this period the fuel consumed by the engine will amount to about 24,000 tons. The relative cost of fuel and liners is as follows :—

	£
Cost of eight new liners, including fitting	1,000
Cost of fuel at 45s. per ton	54,000

From these figures it will be seen that the cost of liner renewals amounts to less than 2 per cent. of the cost of the fuel. If the liners cost even twice this amount, or if their life was only half as long, the expenditure under this heading would be still less than 5 per cent. of the cost of the fuel or less than would be obtained by increasing the specific fuel consumption from, say, 0·36 lb. to 0·38 lb. per s.h.p. hour. Actually, improvements in several directions are serving to reduce still further the expenditure on liner renewals. The importance of carefully centrifuging the fuel for the removal of water and impurities is now generally recognised, but it is considered that further important advantages may be gained by avoiding, as far as possible, cylinder liner distortion and condensation of combustion products due to over-cooling. These results may be effected partly by consideration of design and partly by running engines at high jacket temperatures and with the least possible difference between inlet and outlet temperatures, so that causes for distortion are removed. A high rate of water circulation, the use of fresh or distilled water cooling, heating of liners and pistons before starting, and the avoidance of local hot spots which may limit the average cooling water temperature, are all points which, if attended to, will certainly help towards reducing maintenance costs due to liner wear.

Pistons require to be inspected at intervals of twelve to eighteen months, and it is not unusual to find that the top two rings have to be renewed due either to breakage of the rings, or on account of excessive up and down clearance. If the grooves are worn badly it may be necessary to skim them and fit oversize rings, in which case it is best to adopt a series of standard-dimension rings to which the grooves are adjusted. Another alternative which has given excellent results is to fit a wearing ring of Davey Robertson type, which enables replace rings to be fitted without interfering with the piston. While the cost of piston ring renewals is usually a very small one, the cost of withdrawal for examination and reconditioning may easily amount to as much as liner renewals if the work has to be carried out by shore labour, as is usually the case in tanker vessels. If, however, dismantling for examination is done by the ship's staff, the total expenditure on pistons forms an unimportant item.

No appreciable expenditure is necessary on exhaust or inlet valves provided that clean fuel is used. Exhaust valves should remain in service for at least 1200 hours' running without attention, and at the end of this period they should be in such a condition that they can be replaced after slight regrinding. If time is important, as in the case of tanker vessels, it is usually more convenient to keep a spare set of valves and boxes so that the used valves can be replaced without delay and reconditioned as opportunity occurs. In exceptional cases, where exhaust valves burn out rapidly, the trouble is almost invariably caused by dirt or solid impurities in the fuel which should be removed by efficient centrifuging.

Inlet valves and fuel injection pumps and valves require little or no attention, and do not appreciably influence the cost under this heading.

Running parts, such as main bearings, connecting-rods, top and bottom ends, cam shaft bearings, &c., require practically no attention. In exceptional cases, however, where salt water has had access to the crank chambers, heavy repair costs may be involved due to the development of corrosion on the bearing surfaces.

Fracture of cylinder covers and liners may occasionally occur due to local overheating caused by deposits. The most likely cause of deposits arises when sea-water cooling is employed, as during the vessel's passage up river or in confined water there is always the possibility of contamination of the cooling-water system with finely divided mineral matter which cannot be excluded either by filtration or settling. In parts of the system where the circulation is more or less stagnant, local overheating occurs which progressively increases with deposit formation and eventually results in fracture. In a closed system with fresh-water cooling, the same thing may occur unless special precautions are taken to ensure clean soft water and to avoid any possible contamination from either sea water or lubricating oil. Having already mentioned the advisability of operating engines with the highest possible jacket temperatures, it is clearly advisable to use a closed system with a rapid rate of circulation and to employ distilled water which will also avoid any possible trouble with deposits.

Pistons may be cooled either by water or oil, but having in mind the necessity of introducing the cooling medium either through telescopic or "walking" pipes, there are advantages in using oil which keeps these moving parts in better order and removes any risk of contamination of the bearing oil in cases where the piston-cooling system is partly arranged in the crank chamber.

It is unnecessary to refer in much detail to repairs and maintenance costs of steam machinery. Boiler cleaning, boiler and superheater repairs and surveys are generally the most important items, and in an installation of the size in question would amount to about £400 per annum, assuming that the bulk of this work is carried out by shore staff. In these circumstances the cost of this item may be two to three times the cost of liner renewals in a motor ship. Steam reciprocating engines require very few repairs and beyond the usual examinations and adjustments require little expense in maintenance and upkeep. Where superheat is employed it is to be expected that more attention will be necessary to various details, such as valves, glands, drains, superheat elements, &c., and also in the engine, the H.P. cylinder and piston valve chest liners will require reborings at intervals, and some additional expense in rings as compared with a non-superheated installation.

The repair costs for coal-burning steamships will be slightly higher than for oil burners, this being due to the extra cost of boiler repairs, renewing fire-bars, &c., and also due to the effects of uneven firing and cold air admitted to the furnace during firing which tends to cause unequal expansions and leakage at the tube ends.

The repair costs for turbines are generally higher than for steam reciprocating engines. Whereas in the latter cylinder covers, &c., can be quickly lifted by the ship's staff for examinations of pistons and valves, shore assistance is usually necessary to lift turbine casings to avoid delay. More attention is also required to the condensers and air pumps owing to the higher vacuum which must be maintained for the sake of efficiency. Extra upkeep of pumps, separators, and other devices required in a high-efficiency turbine installation has also to be provided for. Troubles due to erosion or corrosion of blading have been practically eliminated since suitable qualities of material such as manganese bronze, Monel metal, and special alloy steels have been adopted. Injection of paraffin into turbines has been found very beneficial, and not only keeps the blading clean, but also acts as a lubricant in the air and feed pumps. It also reduces the possibility of priming and prevents scale from adhering to the surfaces of boilers.

The problems connected with reduction gearing appear to have been completely solved, and it is not anticipated that in a modern installation any appreciable upkeep costs will be incurred in this part of the machinery.

Capital Charges.—Allowance for interest on capital, depreciation, and insurance forms one of the major charges in the running costs of a vessel. Although this is a matter which is not strictly within the scope of a paper dealing with fuel and maintenance costs, the authors indicate below the effect of this factor on the vessel already considered. These costs are considered to be reasonably accurate for comparison purposes, but, naturally, individual engine builders may, under stress of competition, be prepared to offer more favourable prices than those indicated, and the capital charges will thereby be proportionately reduced.

It will be observed that the initial charges and estimated cost per ton mile are calculated on the basis of

* N.E.C. Inst. From a paper entitled "Fuel Consumption and Maintenance Costs of Steam and Diesel-engined Vessels," by L. J. Le Mesurier (Member), and H. S. Humphreys.

12½ per cent. to cover all charges related to capital cost. The reciprocating steam machinery is assumed to be a highly efficient type with regenerative condenser, superheat and two-stage feed heating, which will be necessary to secure an oil fuel consumption of 0·9 lb. per s.h.p. per hour on which the results have been based. Allowance has been made for the extra cost of seatings for the Diesel machinery. It should also be pointed out that in all proposals 300 steaming days at sea have been allowed for, and no allowance has been made for delay which may possibly occur in vessels fitted with coal-fired boilers. Where such delays occur it will have the effect of reducing the ton miles per annum and would thereby increase the costs above those indicated.

Machinery.	Cost of machinery.	Allowance taken at 12½ per cent. on cost of machinery.	Cost per million ton/miles per annum.
	£	£	£
(*a*) Diesel	52,000	6,500	14·10
(*b*) Turbine (oil)	46,000	5,750	12·90
(*c*) Steam recip. (oil)	36,000	4,500	10·22
(*d*) Turbine (coal)	45,000	5,625	13·03
(*e*) Steam recip. (coal)	35,000	4,375	10·32

The total and detailed costs are summarised in the table below, which shows the cost per 1 million ton miles under each heading, and also the percentage of these costs in relation to the total. These costs are shown diagrammatically in Fig. 2.

Summary of Costs for Various Types of Machinery.

	Repairs.	Stores.	Engine-room wages, &c.	Bunkers.	Machinery only, capital charges.	Total.
(*a*) *Diesel machinery*	£3·03	£1·35	£5·96	£16·90	£14·10	£41·34
Percentage costs	7·3	3·2	14·4	41·0	34·1	100
(*b*) *Turbine (oil)*	£2·92	£1·06	£5·70	£28·40	£12·90	£50·98
Percentage costs	5·7	2·1	11·2	55·7	25·3	100
(*c*) *Recip. (oil)*	£2·50	£1·13	£5·35	£34·42	£10·22	£53·62
Percentage costs	4·7	2·1	10	64·1	19·1	100
(*d*) *Turbine (coal)*	£3·13	£1·10	£8·58	£25·20	£13·03	£51·04
Percentage costs	6·1	2·2	16·8	49·4	25·5	100
(*e*) *Recip. (coal)*	£2·71	£1·18	£8·25	£30·70	£10·32	£53·16
Percentage costs	5·1	2·2	15·5	57·8	19·4	100

Administration and Port Charges.

Although these have not been taken into account, it may be mentioned that owing to the Diesel vessel's carrying more cargo than identically similar vessels with the same draught and displacement, but with other type of machinery, these charges will be proportionately less.

Conclusions.

Fuel consumption is the most important factor affecting the relative running costs of vessels fitted with different types of machinery, the next most important factor being the capital cost. A comparatively small gain in fuel economy will generally prove far more important than considerable differences in relative repair costs or other factors which have been referred to. The cargo-carrying capacity may be greatly affected by the fuel consumption depending upon the trade route, bunkering conditions, and steaming radius, while these conditions will also similarly affect the actual fuel costs. It is therefore not intended by the authors that any broad conclusions as to the most suitable type of machinery for all classes of vessels should be drawn from the analyses given above. Each particular case must be dealt with on its own merits. It should, however, be noted that in the case of Diesel machinery this important factor of fuel consumption can be predicted with no appreciable margin for error, but with steam machinery an allowance must be made to cover variations in performance due to the human element, which so largely controls the running of this type of machinery, and also for variation in performance caused by the state of boiler surfaces and conditions of superheat, feed temperature, and vacuum.

It is hoped that the brief reference made to different types of propelling machinery may encourage users to give the results of their experiences, particularly in regard to fuel consumption and maintenance. As, however, machinery type and not hull performance is in question, it is considered essential that where fuel consumption is given it should be based on the actual specific fuel consumptions obtained from a carefully ascertained power output. Fuel coefficients which take into account both machinery and hull performance are of very little interest in the subject under discussion.

American Engineering News.

Large Electric Mine Hoist.

The largest electric hoist for metal mines in the United States is of 3000 h.p., but the motor develops peak loads up to 5000 h.p., while the 44-ton fly-wheel—with a peripheral speed of 4 miles per minute, limits the demand on power supply to 1800 h.p. This new hoist is at the mines of the Homestake Mining Company. The ore hoist operates in two compartments with normally balanced skips, each holding 7 tons of ore. With a drum speed of 35 r.p.m., the average rope speed is 2250ft. per minute, with about 2½ min. to raise from the lowest level at 5275ft. from the surface. A man and material operates a 2-ton, two-car cage in one compartment, with a 4½-ton counterweight. The ore hoist has two 1500 h.p., 600-volt motors running at 300 revolutions. Its motor generator set includes two 1200-kW generators of 600 volts, a 2200-volt, 1750-h.p. induction motor, a 250-volt, 40-kW exciter, and a 44-ton fly-wheel. For the man-hoist there is one 1500 h.p. motor, a motor generator set and a 34-ton fly-wheel. These wheels, 12ft. in diameter, are built up of steel plates. Flexible couplings connect the motor shafts to the drum shafts. The induction motors are of the wound-rotor type, to secure the required variation in speed for effectively utilising the fly-wheels. The capacity of these motors corresponds to the average load during a hoisting cycle, the peak loads being carried by the fly-wheels. Full control of the hoist is accomplished by adjusting and reversing the generator field current through a controller handling only one-sixth ampère. Dynamic braking is afforded automatically when retarding or lowering overhauling loads. This method ensures safety without resorting to the mechanical brakes, these serving principally to hold the drum stationary between trips. A master switch in connection with a magnetic contactor gives the operator control of the generator voltage. Hand control of the speed is provided by twelve graduated stops from standstill to full speed, and if the master switch should be moved instantly to the full-speed position, these contactors would still close in proper sequence to control the speed.

Developments in Welding.

Further improvements in and additional applications of welding continue to be reported frequently by American works. For instance, there is the depositing of one alloy steel upon another by atomic hydrogen welding, so that the finished piece combines two kinds of metal to suit different purposes. Thus, valves for large gas and Diesel engines are of forged-chrome-molybdenum steel with fused seats of another alloy of higher resistance to heat and wear. By the same process, insert rings of chrome-vanadium steel in the valve seats are surfaced with the same alloy. In both cases the thickness is $\frac{1}{16}$in. to $\frac{1}{8}$in., and a valve cut for examination shows no line of separation. As the hydrogen flame envelopes the work in a reducing atmosphere, it prevents oxidation of the fused metals. At one steel works it has been found economical to install pipe distribution for both oxygen and acetylene in the tube mill and open-hearth mill for cutting scrap and tapping the furnaces. There is better control of pressure and gas consumption, while the delay and inconvenience of handling the gas cylinders is eliminated. At the furnaces, also, delays in tapping due to exhaustion of oxygen tanks are avoided, as well as the possibilities of the cylinders coming into contact with molten metal. In these distribution lines the pipes are welded, as well as the 12in. pipes of a water line 800ft. long under 1200 lb. hydraulic pressure. Where steel castings are included in welded work, efficient results depend upon co-operation between the designing, engineering, and fabrication departments of both the casting and welding concerns. At one steel mill, where ingots are of the "three-wing" or "clover leaf" section, the billets are cut by oxy-acetylene torches. To time the power supply to resistance welders automatically by controlling the contactor on the welder, a new synchronous motor-operated timer has been developed. Its timing is not affected by variations or surges in line voltage, and it can be adjusted for the welding of two pieces of different thicknesses.

American Motor Vehicle Taxes.

A recent report on an investigation made by the United States Bureau of Public Roads as to the total of taxes on the owners of motor vehicles, shows the enormous figure of £200,000,000 for the year 1932. This includes federal, state, county, and municipal taxes, property taxes by states, counties and municipalities, and public bridge tolls. Fees and taxes of the several States include the following :—

	Number.	£
Passenger cars and taxi-cabs	20,836,362	43,100,000
Motor coaches and omni-buses	49,452	700,000
Motor trucks and tractor trucks	3,229,315	14,045,000
Trailers and semi-trailers	415,276	700,000
Motor cycles	89,197	65,000
Total	24,619,602	£58,610,000
		£
Special motor vehicle carrier fees		1,040,000
State petrol taxes		102,600,000
Operators' and chauffeurs' licences		3,660,000
Miscellaneous		1,856,000
Total States' fees and taxes		£167,766,000

In addition, there was £18,476,000 for manufacturers' excise taxes by the Federal Government, £340,000 for county fees and taxes, £2,830,000 for municipal fees and taxes, £7,178,000 for personal property taxes, and £3,640,000 for public bridge and ferry tolls, making a grand total of £200,230,000. Passenger cars constituted 84·30 per cent. of all vehicles; motor trucks and tractor trucks, 13·1 per cent.; trailers and semi-trailers, 1·7 per cent.; motor cycles, 0·4 per cent.; taxicabs, 0·3 per cent., and motor omnibuses, 0·2 per cent. For 1933, incomplete records show a reduction in number of passenger vehicles and in some of the tax items; but the petrol taxes of the States were about £1,000,000 higher, and the Federal excise taxes about £30,000,000 higher, so that the grand total was some £27,000,000 higher than for 1932, or, say, £227,230,000. There is no uniformity in the rates and methods of taxation in the forty-eight individual States, extreme variations occurring in the basis on which registration fees were charged, including gross and net weight, load capacity, horse-power, and value.

Disposal of Sewage Sludge.

A problem that has become more and more insistent for solution with the rapid increase in number and size of sewage treatment plants in the United States is that of disposal of the sludge resulting from the purification treatment. While digestion in tanks has reduced the bulk and the nuisance factor, the later development of the activated sludge process complicated the problem by increasing the bulk of sludge and rendering it resistant to digestion. Thus, the disposal by drying on sand beds after digestion appears to be less effective with sludge from the relatively new process. Two very different lines of disposal are now in use and being studied as to their further development. In one method, the sludge is de-watered by mechanical devices, and the dried cake is then burned in an incinerator, with or without additional fuel. This method has been adopted for one of the large sewage works at Chicago, where the heat will be utilised to generate steam and produce power for the operation of the works. Since the only residue is fine ash, the sludge is disposed of finally. The other method is to collect the gas produced in the digestion tanks and use it for power purposes as well as for heating the tanks and buildings. At a plant to be built in New York the gas will be used to operate sewage pumps, and the same plan is proposed at Toledo, where extensive study has been made of the possibilities of thus using gas-engine pumps. At the Springfield activated sludge sewage works, the gas has long been used to drive the air compressors. Further development lies with the improvement of de-watering apparatus and incinerator apparatus to secure higher efficiency. Research and experimental work is being carried on for this purpose at various works and by several engineers, as well as manufacturers of the apparatus. It has been suggested that the two methods might be used in combination, the sludge being partially digested to produce a given amount of gas, and then being finally disposed of by incineration with utilisation of the heat from combustion.

THE INSTITUTE OF PHYSICS.

A Conference on Industrial Physics will be held in Manchester on Thursday, March 28th, and will continue until Saturday, March 30th, 1935. The Institute of Physics is responsible for the Conference, and the President of the Conference will be Professor W. L. Bragg, F.R.S. An exhibition of instruments, apparatus, and books cognate to the subject of the Conference will be held in the laboratories of Manchester University. The subject of the Conference is "Vacuum Devices in Research and Industry," and the lectures and discussions chosen for this occasion are: "Modern Electrical Illuminating Devices," "Applications of Photo-electric Cells," "The Cathode-ray Oscillograph in Research and Industry," "Recent Applications of Mercury Vapour Rectifiers and Thyratrons," "High-Tension Vacuum Tube Devices in Research and Industry," and "X-rays in Industry." Visits will be made to local works and research laboratories. A Conference dinner will be held in the College of Technology. Full particulars may be obtained from the Secretary of the Institute of Physics, 1, Lowther-gardens, London, S.W.7.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Mr. J. W. Kidd, the general manager of the Metropolitan-Cammell Carriage and Wagon Company, Ltd., has been appointed to the board of the Midland Railway Carriage and Wagon Company, Ltd., with effect from February 6th, 1935.

Mr. J. M. Shackleton, M.I.E.E., superintending engineer, Post Office, Engineering Department, Preston, retired on January 31st, 1935, after nearly forty years' service. He joined the late National Telephone Company at Dublin in 1895.

Mr. Alvero Hollowday.—We have to report with regret the death of Alvero Hollowday, A.M.I. Mech. E., sales engineer for Ruston-Bucyrus, Ltd., of Lincoln. His practical knowledge of excavators was gathered from large contracts, including Heysham Harbour and Immingham Docks, where he was employed respectively as chief plant engineer and chief mechanical engineer, and his loss will be deeply felt by Ruston-Bucyrus, Ltd., and the many users of excavating machinery with whom he came into contact.

Detel Red.—We have received a sample of a paint, or varnish, from Detel Products, Ltd., of Long Drive, Greenford, Middlesex, which seems to have remarkable corrosion-resisting qualities. It is obviously compounded with a rapidly evaporating solvent, but details of the formula are, naturally, not disclosed. It can be applied with either a brush or a spray and will effectively resist acids, alkalies, petrol, lubricating oil, and the majority of chemical solutions, but it will not stand up to such solvents as anyl acetate. A characteristic which struck us in our experiments is that, while the varnish is highly inflammable when it is freshly applied, on drying out it has a protective action against fire. The varnish can be obtained coloured with a few of the common pigments, such as, we should imagine, iron oxide for the Detel Red.

International Combustion, Ltd., Staff Dinner.—The first staff dinner of International Combustion, Ltd., took place on Friday, February 15th, at the Restaurant Frascati. From small beginnings in 1923 the firm has grown so rapidly that about 130 members of staff sat down to dinner together with some 50 guests. The chair was taken by the chairman of the company, Mr. George R. T. Taylor, and the toast of "The Company and the Staff" was proposed by Viscount Monck in an amusing speech. The chairman and Mr. George C. Usher, the managing director of the company, ably responded. Mr. Usher referred in his speech to the progress which has been made by the company and the success which has attended it since its inception. In the unavoidable absence of the Lord Portal of Laverstoke, the toast of "The Guests and Overseas Friends" was proposed by Mr. Frank Hodges, and Captain Leslie Gamage replied. Between the speeches musical and entertaining items were given, and a very enjoyable evening was spent.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Our Steel Imports.

The Board of Trade Returns for January so far as they concern iron and steel imports and exports do not make very satisfactory reading. The total imports of iron, steel, and manufactures thereof amounted to 130,544 tons, which was the largest monthly total reported since May, 1932, when the figure was 144,000 tons. The January total also showed a sharp increase over the December imports of more than 16,000 tons, the figure for the last month of 1934 being 114,498. It is interesting to note that the monthly average of iron and steel imports for 1933 was 80,900 tons, and that the quantities imported in January approximated closely to the monthly average for 1932 of 132,800 tons. In January the imports of pig iron were 7428 tons, a considerable reduction upon the December tonnage of 12,284. This decline was almost entirely due to a drop of over 5000 tons in imports from India. On the other hand, the imports of blooms, billets, and slabs which were probably stimulated by the desire of consumers to secure supplies of foreign material before a possible increase in the duties, rose from 25,892 tons in December to 31,231 tons in January. As usual, Belgium was the largest supplier with 15,504 tons, France coming next with 8443 tons. There was also an increase in the imports of sheet bars which, for January, were 18,664 tons, against 15,786 tons in the previous month, the supplies coming entirely from Belgium and Luxemburg with 15,584 tons and 3080 tons respectively. There was a rise in the tonnage of wire rods brought into this country, the January total being 9858 tons, against 7690 tons in the previous month. There was little difference in the January and December imports of girders, beams, joists, and pillars, which totalled 6816 tons and 6576 tons respectively. The quantities of hoop and strip amounted to 7874 tons, against 6152 tons in December. Imports of plates and sheets also increased to 4139 tons in January, compared with 2694 tons in December. Belgium was by far the largest importing country in January, the total being 70,238 tons, Luxemburg came next with 14,825 tons, and France third with 14,021 tons. Apart from British India, which imported 5069 tons of pig iron, other British countries contributed 8307 tons of the total imported during the month.

The Steel Export Figures.

British exports of iron and steel reached a total of 181,211 tons in January, compared with 186,824 tons in December. Taken by itself the decline may not be regarded as more than a normal trade fluctuation; but when it is realised that it is necessary to go back as far as April, 1934, to find so low a figure, it becomes matter for consideration. In April last year, the export tonnage dropped to 165,200 tons, and in the intervening period it reached a peak at 220,900 tons in October. Some satisfaction, however, may be found in the fact that it is well above the monthly average of exports for 1933, which was 160,200 tons, and for 1932, which was 157,300 tons. The exports of pig iron improved to 11,225 tons in January from 10,068 tons in December. The exports of general descriptions of steel showed little variation, being, for January, 15,938 tons, and for December 15,517 tons. South Africa and British India were the best customers, with 4022 tons and 3456 tons respectively. There was a noticeable increase in the exports of plates and sheets not under ¼in. thick to 12,883 tons in January from 9895 tons in December. Exports of plates and sheets under ¼in. thick reached 12,757 tons compared with 9847 tons in December. Of the January total, the Argentine Republic took 5089 tons, and British India 2114 tons. The exports of galvanised sheets, however, declined to 23,091 tons, compared with 27,914 tons in December, and the tin-plate figure dropped to 25,663 tons in January from 30,413 tons in the previous month. There was an increase in the exports of railway material from 10,403 tons in December to 12,564 tons in January. The total for January included 8705 tons of steel rails, 699 tons of sleepers and fish-plates, and 1684 tons of tires and axles. The best customer was South Africa, with 6981 tons, British India being next with 1147 tons. Of the total January exports of iron and steel, South Africa took 27,330 tons, British India coming second with 25,714 tons, and Australia third with 11,972 tons. Amongst other countries the Argentine Republic took 10,282 tons, Holland 6479 tons, Denmark 5278 tons, Canada 4133 tons, and British Malaya 5166 tons.

The Pig Iron Market.

The chief characteristic of the pig iron market at the moment is the steadiness of the demand. The volume of trading is not so large as a few weeks ago, and business consists principally of small parcels, but if the demand does not increase it shows no signs of shrinking. The market seems confident that the position is more likely to improve than to decline, and points to the heavy tonnage of contracts on the makers' books as the reason for the comparatively quiet conditions which rule. On the North-East Coast some buying for second quarter delivery developed lately, but the demand was soon satisfied. Stocks have been reduced, and as a consequence there is less inclination on the part of producers to quote cheap prices for export. The desire to retain old-established foreign connections often results in export transactions at prices which would not otherwise be acceptable. The greater part of the recent overseas business has been with Scandinavian markets, but recently about 1000 tons of ferro-manganese was shipped to Australia. The current home demand for Cleveland foundry is moderate, but the local foundries, particularly the pipe foundries, have a good tonnage of work in hand, and it is anticipated will be good customers to the pig iron makers in the near future. Business in Midland irons has been irregular of late. The rate of operations at the light castings foundries varies considerably, and whilst some are well supplied with work, others are in need of orders. Practically all the important buyers of Midland foundry irons have covered their prospective requirements until the end of the second quarter, and taking good deliveries. Current business, therefore, depends upon the smaller concerns which satisfy their needs as they arise. On the whole, the Scottish industry is holding the improvement made in the second part of January. Out of the twelve furnaces in operation in Scotland, six are engaged upon foundry qualities, and the output seems to be passing into consumption. A disappointing feature of the pig iron market in all districts is the slow demand for forge iron. Recently some improvement was noted in the tonnage passing into consumption, but this movement did not last long. Fresh activity has developed in the hematite market, and a fair number of contracts have been placed by users.

British Iron and Steel Production.

The British Iron and Steel Federation, in its monthly statement for January, gives the production of pig iron in that month as 521,200 tons, against 513,500 tons in December, and 441,300 tons in January, 1934. The total includes 123,900 tons of hematite, 262,100 tons of basic, 118,800 tons of foundry, and 7700 tons of forge pig iron. In January, 757,800 tons of steel ingots and castings were produced, compared with 654,500 tons in December, and 711,000 tons in January last year. On January 31st, there were ninety-four furnaces in blast, against ninety-six at the end of December, three furnaces having commenced operations and five having been blown out. Although the report does not give details of the furnaces which were started up, one was at the works of Stewarts and Lloyds, Ltd. (Hickman), Wolverhampton; one at John Lysaght, Ltd., Scunthorpe, and one at the Staveley Coal and Iron Company, Ltd., Chesterfield. Of the five blown out during the month two were shut down at Colvilles, Ltd., for alterations and repairs, and are expected to restart shortly; one was blown out at the works of Wm. Baird and Co., Ltd., Gartsherrie; one at Stewarts and Lloyds' Corby works, and one at Shotts Iron Company, Ltd. The following table shows the average monthly production of pig iron and steel over a period of years, and the output for the past four months :—

	Pig iron, tons.	Steel, tons.
1913—Monthly average	855,000	638,600
1920 ,, ,, ...	669,500	755,600
1929 ,, ,, ...	632,400	803,000
1932 ,, ,, ...	297,800	438,500
1933 ,, ,, ...	344,700	585,300
1934 ,, ,, ...	498,200	738,300
October	527,100	812,000
November	507,600	766,000
December	513,500	654,500
1935—January	521,200	757,800

The North-East Coast and Yorkshire.

All the works on the North-East Coast are busily employed on substantial contracts resulting from the railway companies' programmes, from shipbuilding orders, and from the busy conditions ruling at the constructional engineering works. General trading, however, is confined to small orders. Since the middle of January, until the first few days of February, new business of this class was distinctly scarce; but the first half of this month has brought an improvement, and lately there has been a steady flow of home and export orders. The requirements of the constructional engineers are considerable, and most of them have sufficient orders to keep them employed for some time to come. There is also a good deal of potential work in view for this industry in the nature of contracts which are likely to be given out by municipalities and other public authorities. The orders taken early in the year for shipbuilding are now reflected in a good run of specifications for steel; but fresh contracts for ships are required to maintain the demand from this industry. The rail mills have been making good outputs for some weeks and are now beginning to require new orders. It is believed that these will be forthcoming in the near future, and that it is unlikely there will be any serious slackening in production by this department. The sheet trade is still suffering from a scarcity of export business, although during the past week or two there has been some improvement in this direction. The home trade, however, is absorbing a good tonnage of the thicker gauges, and the requirements of consumers in this country seem to be expanding. The Yorkshire steel makers continue to maintain the excellent rate of activity which has characterised the market for the past few months. The Sheffield basic steel works are experiencing a steady pressure of business, and, in fact, all the principal sections of the industry in this centre are well employed. The acid steel department, however, is not so busy as is the basic. The production of tool steel is not on such a good scale as at this time last year, but the toolmakers in the district have improved their position lately, and it is expected that the demand for steel will increase shortly. Business in stainless steel does not vary much, and the production remains at a high level.

Current Business.

The Admiralty has decided to place an order for a net-layer protector for the 1934 programme with Yarrow and Co., Ltd., Scotstoun; the vessel will have a displacement of 3000 tons. The British Thomson-Houston Company, Ltd., of Rugby, is to receive an order for a large generating plant from the County of London Electric Supply Company, Ltd. The Lancashire Electric Power Company has also placed an order for a 50,000-kW turbo-alternator for installation at the Kearsley power station. The alternator on that machine will be wound for 33,000 volts. The board of John Lysaght, Ltd., has decided to install at Newport, Mon., one of the newest type of four-high, reversing, cold-finishing mills. The design of the plant has been worked out by the United Engineering and Foundry Company, Ltd., Pittsburgh. A Diesel paddle tug has been ordered by Lynch Brothers, Ltd., from the Ardrossan Dockyard, Ltd., for towing lighters on the river Euphrates. The London Power Company, Ltd., has applied for the consent of the Electricity Commissioners to the installation of three further boiler units at the Battersea power station. This will complete the existing boiler house of the first half of the station. The Department of Overseas Trade announces that the following contracts are open for tender :—Controller of Stores, North-Western Railway, Lahore: 45 smiths' bellows, 40 portable forges, 25 screw jacks, 12 differential pulley blocks with chain (Western Improved), and 20 riding trolleys (Lahore, March 20th). Indian Stores Department: One 100-kW oil-engine-driven generating set, including a 440–500-volt D.C. generator, directly coupled to a multi-cylinder, vertical, crude-oil engine with control panel (New Delhi, March 21st). Siam, Royal State Railways: 1610 wheel tires for engines, carriages, and wagons (Bangkok, April 5th). New Zealand, Public Works Department: 5-ton hand-operated overhead travelling crane (Wellington, March 19th). Egypt, Ministry of Finance: 4000 tons of light and heavy section, new or second-hand, rails—15 kilos. and 30 kilos. per metre run—(Giza, March 23rd).

Copper.

The electrolytic copper market appears to have regained its tone following the disturbed conditions which existed last week. It is generally assumed that no further financial trouble is to be expected in the metal markets, and now that the Dollar-Gold Clause decision has been given in favour of the American Government the uncertainty arising from this source also has been removed. The American copper trade has been greatly affected by the United States Supreme Court's decision having been held so long in suspense, and now some confusion with regard to quotas seems likely to occur amongst the producers themselves owing to the purchase of the United Verde Company by the Phelps Dodge interests. This will make the Phelps Dodge Corporation the second largest producer in the United States, the total output being 236,000 tons per annum. The market is still without much information as to the progress of the negotiations for the curtailment of production. Representatives of the European producers have recently been in New York discussing the copper trade problems, but their discussions have been hampered by the gold-dollar controversy, and now that this is out of the way fresh efforts are likely to be made to reach an understanding. So far it is reported that the European and African producing interests have suggested terms which have been entirely unacceptable to the Americans. Prices in the London standard market have been very steady this week.

The Tin Market.

Excepting for the backwardation which fluctuates closely around £4, the tin market pursues an uneventful course. Prices, after showing some weakness in the absence of support, have become firmer; but this can scarcely be said to have been the result of buying by the consuming trades. In fact, the demand from users has been so poor as to lend some support to the statements of the opponents of the restriction scheme that the present high level of prices creates an incentive for the use of substitutes. At the moment the market is passing through a period of revolt against the rigid control to which it is subjected and against the operations of various pools. So long as the restriction scheme is supported by the Governments, however, it is difficult to see how conditions can be altered. There is certainly a strong feeling that the "Buffer Pool," which was formed to preserve the market from the effects of scarcity, should be used to relieve the present stringency of prompt metal, which is the cause of the backwardation. American buying has been on a poor scale for some weeks, and the Continent has bought little.

Lead and Spelter.

Trading in the lead market has been uninteresting. The demand from consumers is steady and is on a substantial scale, although perhaps not quite up to that which existed during the greater part of last year. This was unusually heavy, the quantity consumed in the manufacture of pipes and sheets for 1934 alone approximating 140,000 tons. Consignments of Mexican lead have been declared on the market, but these have been absorbed without difficulty, and it is understood that some will be exported to Russia to fulfil sales made a short time ago, and the remainder will go into bonded warehouse. The position as regards Empire brands is unaltered and premiums of 15s. or so are asked for non-dutiable metal. Trading in this market, however, is not likely to become normal until the decision of the Import Duties Advisory Committee regarding the working of the 10 per cent. duty imposed by the Ottawa agreements is made known. . . . In the spelter market prices have fluctuated within moderate limits and at times a fair amount of interest has been shown by operators. Consumers, however, have taken comparatively small quantities, although on the whole the demand is fairly well maintained. It is anticipated that the arrivals of spelter from foreign sources this month will be less than was originally expected, as the Polish producers have recently made substantial deliveries to Japan. The American position shows no signs of improving and the stocks of spelter at the end of January were 119,900 tons, which was practically the same as at the end of December.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.: plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. COAST—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 8 6	3 2 0
No. 1	3 9 0	3 2 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/– rebate*)	3 7 6	—
MIDLANDS—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/– rebate*)	3 12 6	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/–rebate*)	3 7 6	—
N.W. COAST—		
Hematite Mixed Nos.	3 12 6 d/d Glasgow	
	4 0 6 „ Sheffield	
	4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
LANCS.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. YORKS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
MIDLANDS—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	7 5 0 to 7 15 0	—
SCOTLAND—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. COAST—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home.	Export.
LONDON AND THE SOUTH—	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	—
Flats, 5in. and under	8 14 6	7 2 6
Plates, ¼in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 10 0	8 5 0
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 5 0	8 5 0
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 7 6	7 15 0 to 8 5 0

STEEL (*continued*).

	Home.	Export.
GLASGOW AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 9	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates	9 5 0	8 5 0
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 10 0	8 5 0

IRELAND—	BELFAST. £ s. d.	REST OF IRELAND. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	9 0 0	8 15 0
14-G. to 20-G., d/d	10 5 0	9 0 0
21-G. to 24-G., d/d	10 10 0	9 5 0
25-G. to 27-G., d/d	11 2 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £16 12s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18/2 to 19/2.
Tin-plate Bars, d/d South Wales Works, £5 7s. 6d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 tons	5 15 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 12 6	7/–
„ „ 8 p.c. to 10 p.c.	£21 12 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 0 0	11/–
„ „ „ 1 p.c. carbon	£38 15 0	12/–
„ „ „ 0·70 p.c. carbon	£42 0 0	12/6
„ „ „ carbon free	10d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 19 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Ferro Cobalt	5/3d. per lb.	

NON-FERROUS METALS.

Official Prices, February 20th.

COPPER—	
Cash	£27 3 9 to £27 5 0
Three months	£27 10 0 to £27 11 3
Electrolytic	£30 10 0 to £30 12 6
Best Selected Ingots, d/d Birmingham	£31 0 0
Sheets, Hot Rolled	£58 0 0
	Home. Export.
Tubes, Solid Drawn (basis)	9½d. 9½d.
„ Brazed (basis)	9½d. 9½d.
BRASS—	
Ingots, 70/30, d/d Birmingham	£27 0 0 to £29 0 0
	Home. Export.
Tubes, Solid Drawn, 2/1 Alloy	8¾d. 8¾d.
„ Brazed	10¾d. 10¾d.
TIN—	
Cash	£228 17 6 to £229 0 0
Three months	£224 10 0 to £224 15 0
LEAD:	£10 5 0 to £10 8 9
SPELTER:	£11 16 3 to £12 0 0
Aluminium Ingots (British)	£100

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
f.o.b. Grangemouth)—Navigation Unscreened	13/– to 13/6
„ Glasgow—Ell	16/6
„ „ Splint	17/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	14/– to 14/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Prime Steam	14/–
Unscreened Navigation	12/6 to 13/–
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	14/3 to 14/6
Secondary Steam	13/3 to 13/6

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	15/– to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	14/3 to 14/9
„ Second	13/3
„ Best Small	10/6 to 11/–
Unscreened	12/6 to 13/6
DURHAM—	
Best Gas	14/8
Foundry Coke	18/6 to 22/6

SHEFFIELD—	Inland.
Best Hand-picked Branch	24/– to 26/–
South Yorkshire Best	21/– to 23/–
South Yorkshire Seconds	17/6 to 19/–
Rough Slacks	8/– to 9/–
Nutty Slacks	7/– to 8/6

SOUTH WALES.

CARDIFF— Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	24/– to 37/6
Furnace Coke	19/– to 21/6
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	34/– to 40/–
Machine-made Cobbles	41/– to 51/–
Nuts	40/– to 50/–
Beans	25/– to 30/–
Peas	19/– to 22/6
Rubbly Culm	10/6 to 11/–
Steam Coals:	
Large	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

French Air Services.

THE changes effected in French aviation of late years enabled the Air Minister, General Denain, to affirm recently that in 1936 it will more than hold its own in the European competition for supremacy. Not so long ago the air services appeared to be hopelessly disorganised, with twenty aircraft firms turning out heterogeneous types of machines and existing, for the most part, on the precarious distribution of State orders. When the air services were unified by the creation of "Air France," the aircraft industry itself had to be organised to meet requirements for the economical production of a limited number of settled types of machines. General Denain insisted upon amalgamations of aircraft makers into six groups, with factories distributed over the country instead of being dangerously concentrated in and around Paris. That work is now well advanced. The amalgamations include Lioré et Olivier and Dewoitine; Louis Breguet, Wibaut-Penhoët and Morane Saulnier; Chantiers et Ateliers de la Loire and Nieuport-Astra; Farman, Blériot and the Ateliers de Construction du Nord de la France under the name of the Union Corporative Aéronautique; Potez, Chantiers Aéromaritimes de la Seine, the Compagnie Aérienne Bordelaise, Bloch and Moteurs Lorraine. The factories are distributed mainly in the western and southern parts of the country. The removal of aircraft engine works from Paris is a more difficult matter on account of the necessity of providing for skilled labour, but arrangements have been made for the installation of the Gnome et Rhône factory at Bourges, where the State arsenal offers facilities for labour supply. Important developments are taking place in the air services. Light fast aeroplanes are to be employed for mails between Paris and distant home centres, and particular importance is attached to the South American service, which is already being accomplished with fair regularity by the new seaplanes. The service, however, cannot be profitable unless the machines carry paying loads of passengers. For that reason, Latécoère has constructed the huge seaplane, "Lieutenant-de-Vaisseau-Paris," which is now undergoing its trials, so far with success. It has two passenger cabins superimposed, and is designed to carry a load of 37 tons. Its estimated cruising speed is 140 miles an hour. This machine is a direct challenge to the German airship, which, it is expected, will initiate a regular service between Europe and Buenos Ayres in the spring, and this competition will be carried on vigorously, not only to South America, but also to the United States. A Government representative has left for the States to investigate the possibility of creating refuelling stations in the Atlantic, so that machines will not be obliged to sacrifice paying load to the necessity of carrying fuel for the entire journey. The representative will return to France by the South American route in order to ascertain in what manner the same problem can be solved.

The Claude Sea Power Scheme.

Monsieur Georges Claude has cabled an account of the circumstances under which he was obliged to abandon his attempt to install the vertical tube from the ice-making cargo ship "Tunisie" off the coast of Brazil. The lowering of the tube began on February 8th, and when five lengths had been immersed, under conditions that gave promise of the whole operation being terminated in less than forty hours, the lower section, with the anchoring weight, became detached. Monsieur Claude believes that a length of tube broke through defective manufacture. It could not resist the swaying of the mass, though the sea is said to have been calm. This disappointment was too much for Monsieur Claude, who declared that it put an end to his experiments, and in order to remove all temptation to resume them he sank the sphere from which the tube was to have been suspended. He believes, nevertheless, that his experience will be of value in any efforts that may be made in the future to put into successful operation a scheme which, he is convinced, is sound and practicable.

Gold Countries and Trade.

Delegates from gold countries met again in Brussels last week to examine the working of the plan for a mutual development of trade. The arrangement to increase import quotas by 10 per cent. failed to satisfy most of the adherents to the gold standard, particularly Belgium and Holland, which find that this small concession has done nothing to improve the situation, and the conference decided that Great Britain should be asked to waive her claim to most-favoured-nation treatment so that the gold countries could allot larger quotas amongst themselves. It was also recommended that Great Britain should take the initiative of showing the way to freer trade by reducing or suppressing tariffs. As the initiative in putting up barriers against British goods came from gold countries, a solution of the problem does not rest with Great Britain alone. This plea for freer trade is, nevertheless, significant of the present state of economic affairs on the Continent.

New Battleship.

Parliament will be asked shortly to vote credits to put in hand a further instalment of the naval construction programme providing for a battleship of 35,000 tons and three destroyers. The new battleship is a reply to two ships of the same tonnage now under construction in Italian yards. At present the "Dunkerque" and the "Strasbourg" leave an available Washington tonnage of rather more than 16,000, so that the new battleship must take precedence over the "Strasbourg," which is to be built in the Penhoët yard, or its construction must be delayed until the expiration of the Washington Convention. Moreover, it is proposed to build a second battleship to identical plans. The French now find themselves in a situation that strengthens their determination to secure better terms under any future limitation agreement, if one can be reached.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

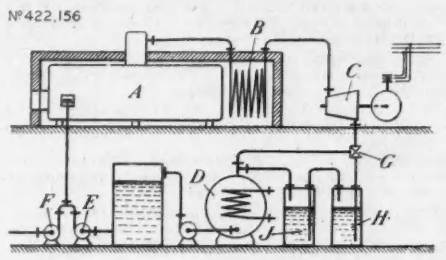
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

422,156. March 19th, 1934.—DE-AERATING FEED WATER, Sulzer Frères Société Anonyme, Winterthur, Switzerland.

This invention is concerned with the de-aeration of the make-up water of boilers. Steam is raised in the boiler A, superheated at B, and employed usefully in the turbo-generator C. It is condensed at D and the condensate returned to the boiler

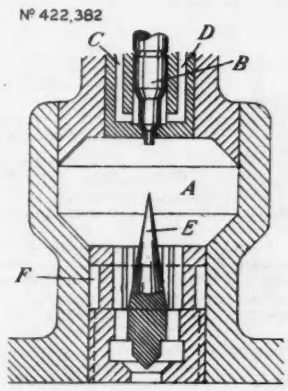


by the feed pump E. The make-up water is supplied by the pump F. Part of the exhaust steam from the turbine is by-passed at G and is passed through solutions of calcium hydrate and sodium sulphite in the vessels H and J. These solutions extract the carbon-dioxide and the oxygen from the steam and leave an insoluble sludge. The purified steam goes on to the condenser D.—*January 7th*, 1935.

INTERNAL COMBUSTION ENGINES.

422,382. April 9th, 1934.—PRECOMBUSTION CHAMBERS, Daimler-Benz Aktiengesellschaft, Stuttgart-Untertürkheim, Germany.

This invention is intended to enable ordinary Diesel engines to work satisfactorily with heavy tar oils. A precombustion chamber A is fixed above the cylinder head and is provided with a fuel injection nozzle B. This nozzle has passages C and D for

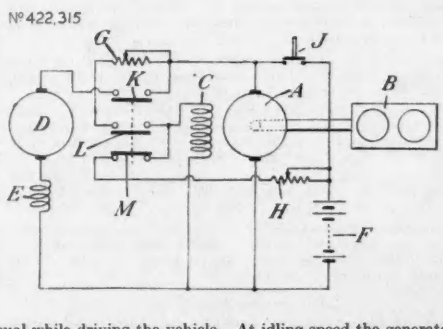


alternative fuels. In the passageway connecting the precombustion chamber with the working cylinder there is a cone E, supported by a spider F. The proportions of this cone are about 1 for the base diameter to 2 for the height. In any case they are such that the angle of the cone approximates to the dispersion of the jet of fuel. The oil runs down the surface of the cone and down the sides of the spider, and picks up the stored heat, so that it is more easily vaporised.—*January 10th*, 1935.

DYNAMOS AND MOTORS.

422,315. May 14th, 1934.—MEANS FOR BATTERY CHARGING IN CONNECTION WITH ENGINE ELECTRIC TRANSMISSION SYSTEMS, Sir W. G. Armstrong, Whitworth and Co. (Engineers), Ltd., Donald John Watkins, and Johann Hermann Abbink-Spaink, all of Scotswood Works, Newcastle-on-Tyne.

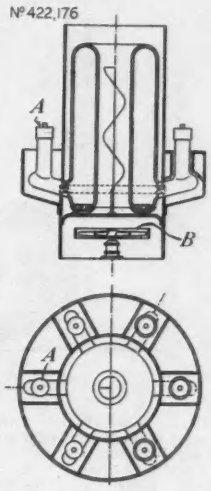
In most engine electric transmission systems associated with vehicles there are periods when the engine is running at idling speed—that is, at a speed lower than the normal speed



usual while driving the vehicle. At idling speed the generator E.M.F. is too low to be capable of charging the battery. According to the invention, means are provided whereby during such idling speed, the battery is used to give the required excitation to the generator so as to raise the E.M.F. of the generator above that of the battery, so that the latter can be charged by the generator. A indicates the armature of a generator driven by an oil engine B, while C indicates the field winding of the generator, D being the armature of a series wound motor adapted to drive the vehicle, and E being the series field winding of the motor. F is the battery. G and H are resistances which may be variable. J is any well-known form of reverse current cut-out or relay for connecting and/or disconnecting the battery and generator A. K L M are contacts. While the vehicle is running, the contact L is closed to connect the winding C to the generator A, and the contact K closed to connect the motor to the generator, the generator running at normal speed. When the vehicle is brought to a standstill or is coasting, so that the engine is idling, contacts K and L are opened and contact M closed. This disconnects the motor and the winding C from the generator and connects the battery to the winding C, so that the generator excitation will be brought to such a value that, even though the armature of the generator is running slowly, the E.M.F. of the generator will be higher than that of the battery. While the vehicle is running, contact K connects the generator A to the motor, while contact L through resistance G connects the generator field C to armature A. Variation of the resistance G will adjust the excitation of the generator. While the vehicle is standing still or is coasting, and while the engine is idling, contact M connects the field C to battery through resistance H. Variation of this resistance will adjust the excitation of the generator under these conditions.—*January 9th*, 1935.

TRANSFORMERS AND CONVERTERS.

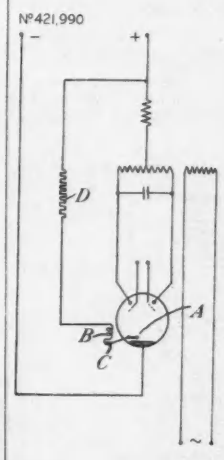
422,176. October 2nd, 1934.—GLASS BULB TYPE MERCURY ARC CONVERTERS, The English Electric Company, Ltd., of Queen's House, 28, Kingsway, London, W.C.2.



The object of this invention is to improve the air cooling of glass bulb rectifiers. To this end the glass vessel has an annular or hollow cylindrical main part, and a number of external anode arms A, arranged substantially parallel to the axis of the main part to which they are connected by laterally projecting elbows, the whole being preferably surrounded by an outer cover which serves both as a support and as a guide for the cooling air. A fan B may be provided below the rectifier to force a stream of air up through the hollow centre of the annular part of the vessel, and between the outer cover and all the outer walls of the vessel.—*January 7th*, 1934.

421,990. July 22nd, 1933.—ELECTRIC INVERTER SYSTEMS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.*

Inverters having mercury vapour filled discharge devices containing a liquid cathode without auxiliary excitation give rise to difficulty in maintaining the cathode spot when the load of the alternating-current circuit changes—that is to say, during the commutation periods of the discharge device. According to the invention, the discharge device is provided with a movable ignition anode A, which is arranged in such a manner that in its position of rest it dips in the mercury of the cathode and under the action of a solenoid coil B an armature C is raised out of the mercury. The ignition anode A is connected through the armature C with the operating coil B, the other end of which is connected through a current-limiting resistance D to the positive pole of the direct-current network. The value of the resistance D is so chosen that a current of sufficient magnitude will flow through the solenoid B to cause the ignition anode A to be raised out of contact with the cathode and enable an arc to flow from this anode to the cathode and produce a cathode spot on the latter. As it is a characteristic of the inverter (to which the present invention is applied) that the load of the inverter



acts itself to maintain a cathode spot, the circuit through the elements D, B, and C does not supply the whole of the minimum current necessary for the maintenance of the cathode spot, but it is designed to produce a sufficient minimum current for maintaining the cathode spot during the commutation periods.—*January 3rd*, 1935.

METALLURGY.

422,167. May 31st, 1934.—IRON ALLOYS, Fried-Krupp Aktiengesellschaft, Essen, Germany.

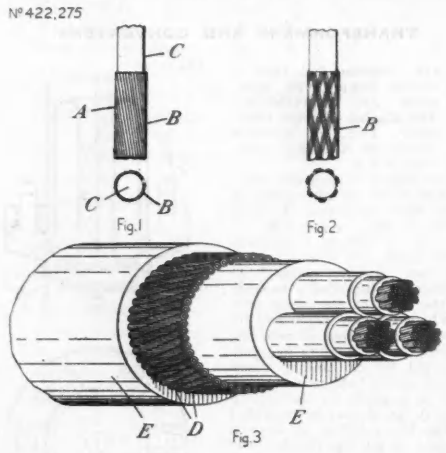
This invention relates to tools or machine parts used in hot working of metals, such, for example, as matrices, pressing plungers, and so forth. These tools or parts must retain their strength when heated in use, and it is desirable that they should be comparatively insensitive to wrong heat treatment. Moreover, they should have a strength of from 89 to 108 tons per square inch, and should be tough. According to the invention, the alloys used for the manufacture of the tools or parts in question contain in addition to iron from 10 to 35 per cent. tungsten, from 0·1 to 0·4 per cent. carbon, and at least one of the elements titanium, vanadium, tantalum, zirconium, uranium, hafnium, and thorium, in a total amount of not more than 10 per cent. These last-mentioned elements have a greater affinity than tungsten for carbon, and accordingly bind the carbon. The alloys that are used may also contain the elements silicon, manganese, phosphorus, and sulphur in the quantities usual in iron alloys, but they do not contain any other elements. The tungsten in the alloys may be wholly or partly replaced by molybdenum. The presence of the carbon and of the element or elements that bind it brings about such a refinement of the texture of the alloy that it possesses sufficient toughness to be useful for practical purposes. Moreover, the melting process is much more simple with alloys containing carbon than with alloys not containing carbon. Furthermore, the alloys used according to the invention may very readily be forged. To illustrate the properties, the following example may be given:—An alloy containing 0·15 per cent. carbon, 0·05 per cent. silicon, 0·24 per cent. manganese, 30·6 per cent. tungsten, and 0·15 per cent. vanadium, after being quenched in water from 1200 deg. Cent., had a hardness of 302 Brinell, and on reheating to 750 deg. Cent. the hardness increased to 477 Brinell. As the carbon content of the alloys rises, more of the element or elements that bind the carbon should preferably be added. In particular, complete combination of the carbon is obtained if the vanadium

percentage is about six times as high as the carbon percentage, the titanium percentage about four times, or the tantalum percentage about 6·5 times as high as the carbon percentage. In order to develop the hardness of the alloys used according to the invention, they are preferably rapidly cooled from a temperature above 950 deg. Cent. and subsequently reheated to a temperature between 400 deg. and 850 deg. Cent.—*January 7th*, 1935.

TRANSMISSION OF POWER.

422,275. July 6th, 1934.—ELECTRIC CABLES, The Enfield Cable Works, Ltd., of Lincoln House, High Holborn, London, W.C.1, Dundas Alexander Smith Porteous and John Whittaker Barnes, both of the works of the company at Brimsdown, Enfield-highway, Middlesex.

In accordance with the invention, a trailing cable has a screen formed of elements called cords, and each cord, which is of circular or approximately circular cross section, consists of a flexible metal conductive covering on a centre of strong flexible non-metallic material. In Fig. 1 the cord A consists of a number of fine wires B applied helically in one direction to a centre C

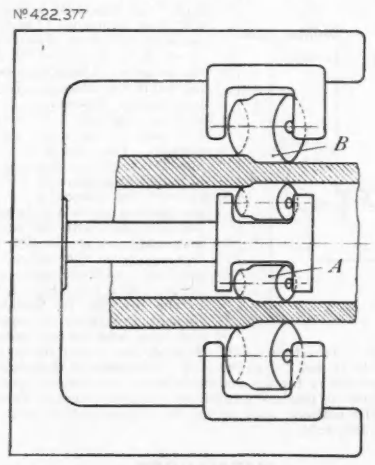


made of twine. In Fig. 2 the flexible conductive covering is formed of two layers of fine wires B. The layers are helical and of opposite hand, and are interlaced to form a braided covering for a centre of twine. In Fig. 3 a trailing cable has an earthing screen D, each cord of the screen being constructed as shown in Fig. 1. The cords are applied helically in one direction to the cable, and are embedded in the tough rubber sheath E. By the invention it is possible to obtain extreme flexibility combined with a very considerable mechanical strength in the screen and to comply with a large variety of requirements.—*January 8th*, 1935.

MACHINE TOOLS AND SHOP APPLIANCES.

422,377. March 29th, 1934.—TUBE ROLLING MILLS, Vereinigte Stahlwerke, Aktiengesellschaft, 67–69, Breitestrasse, Dusseldorf, Germany.

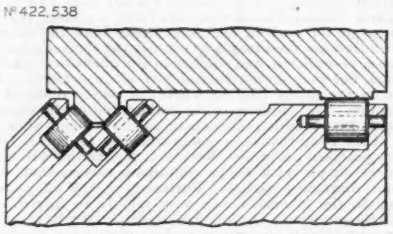
The idea appears to be to use, instead of continuously tapered rolls, for the reduction of tubes, rolls which have a cylindrical part, and will consequently grip the pierced ingot without the



usual tendency towards its ejection. The rolls, as will be seen from the drawing, have a stepped formation, with an intervening incline. The principle applies to both the interior rolls A and the exterior rolls B. The parts of the rolls of smaller diameter enable the partly formed tube to be gripped securely before the major operation is started, and ensure its being fed forward.—*January 10th*, 1935.

422,538. July 12th, 1934.—ROLLER BEARINGS FOR MACHINE BEDS, S. J. Harley, Long Bend, Old Leamington-road, Stivichall, Coventry.

The inventor asserts that there is a tendency for the headstock of, say, a grinding machine to stick on its bed, and resist



movement, on account of the accurate fitting of the sliding surfaces. This adhesion may check the accurate setting of the head. As a consequence, he supports the head on roller bearings, as shown in the drawing, which needs no explanation. It will be noticed that the free roller principle is not adopted.—*January 14th*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF CHEMICAL ENGINEERS.—Hotel Victoria, Northumberland-avenue, W.C.2. Annual general meeting, 11 a.m.; Presidential Address, "Chemical Engineering in Explosives Manufacture," Mr. W. Macnab, 11.45 a.m.; luncheon, 12.45 p.m.; "The Historical Development of Distilling Plant," Dr. A. J. V. Underwood, 2.15 p.m.; annual dinner, 7 for 7.30 p.m.

INST. OF FUEL: EAST MIDLAND SECTION.—Derby Technical College, Derby. "The Evaluation of Coal for Steam Raising," Dr. E. S. Grunell. 7 p.m.

INST. OF MARINE ENGINEERS.—Connaught Rooms, Great Queen-street, W.C.2. Annual dinner. 7 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Annual general meeting. Discussion, "Worm Gear Performance," Dr. H. E. Merritt. 5.30 p.m.

INST. OF PROFESSIONAL CIVIL SERVANTS.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "The Cathode Ray Oscillograph," Mr. R. A. Watson. 5 for 5.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "The Repair of Small Boilers and Pressure Vessels," Mr. F. A. Glidewell. 7.30 p.m.

MANCHESTER ASSOC. OF ENGINEERS.—Engineers' Club, Albert-square, Manchester. "Some Aspects of Budgetary Control," Mr. C. G. Renold. 7.15 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—At Mining Inst., Newcastle-on-Tyne. "Ship Vibration: Simple Methods of Estimating Critical Frequencies," Mr. L. C. Burrill. 6 p.m.

RAILWAY CLUB.—At Royal Scottish Corporation, Fetter-lane, E.C.4. Annual general meeting, Presidential Address, "Eastern Counties Railway." 7.15 p.m.

ROYAL AERONAUTICAL SOC.—At Inst. of Electrical Engineers, Savoy-place, W.C.2. "Research in the R.A.F. Tank," Mr. L. P. Coombes. 6.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, "Some Experiments in Gravitation and Magnetism," Prof. A. O. Rankine. 9 p.m.

TO-DAY TO FRIDAY, MARCH 1ST.

BRITISH INDUSTRIES FAIR, 1935.—London Section. Daily.

SATURDAY, FEB. 23RD.

INST. OF CIVIL ENGINEERS.—Students' afternoon visit to works of Metropolitan Water Board at Stoke Newington, N.

INST. OF ELECTRICAL ENGINEERS: LONDON STUDENTS.—Visit to Barking power Station. 3 p.m.

STEPHENSON LOCOMOTIVE SOC.: MIDLANDS.—At 4, Bury Old-road, Manchester. "The Railways of Norway and Greece," Mr. S. H. Beaver. 6.30 p.m.

MONDAY, FEB. 25TH.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "Factory Accidents: Their Prevalence, Distribution, and Causation," Lecture i, Mr. D. R. Wilson. 8 p.m.

INST. OF MECHANICAL ENGINEERS: GRADUATES' SECTION.—Storey's-gate, S.W.1. "Some Aspects of Workshop Costing," Mr. S. W. Lister. 6.45 p.m.

TUESDAY, FEB. 26TH.

HULL ASSOC. OF ENGINEERS.—At the Municipal Technical College, Park-street, Hull. "Superheat and Superheaters," Mr. W. Hoy. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—North British Station Hotel, Edinburgh. "Electrical Control of Road Traffic by Vehicle Actuation," Mr. T. P. Preist. 7 p.m.

INST. OF ELECTRICAL ENGINEERS: WIRELESS SECTION.—Informal Discussion. "Production Testing of Broadcast Receivers," opener Mr. F. Murphy. 5.30 for 6 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Reinforced Concrete as a Structural Material," Dr. O. Faber. 7.30 p.m.

INST. OF FUEL: NORTH-WESTERN SEC.—Engineers' Club, Manchester. General discussion, "Steam Costing." 7 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield. "Surface Conditions of Files," Mr. A. G. MacDougall. 7.30 p.m.

WEDNESDAY, FEB. 27TH.

INST. OF AUTOMOBILE ENGINEERS.—Engineers' Club, Manchester. "Piston Temperatures on a High-speed, Air-cooled Petrol Engine," Mr. H. Wright Baker. 7 p.m.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOC.—Annual Students' meeting. St. Edmund's Restaurant, Edmund-street, Birmingham. Supper, 6.45 p.m. Discussion, "The Influence of Road Construction on Accidents."

INST. OF ELECTRICAL ENGINEERS: LONDON STUDENTS.—Florence Restaurant, 53, Rupert-street, W.1. Twenty-eighth annual dinner. 7.15 for 7 30 p.m.

INST. OF ELECTRICAL ENGINEERS: N.E. STUDENTS.—Joint meeting with Graduates of N.-East Coast Inst. of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne. "The Transmission of Power by Hydraulic Couplings," Mr. K. Fairbairn. 7.15 p.m.

INST. OF FUEL.—At Chemical Soc., Burlington House, W.1. "Boiler Practice in H.M. Office of Works, with Special Reference to the Use of Blended Coals," Mr. A. G. Pallot. 6 p.m.

INST. OF STRUCTURAL ENGINEERS: SCOTTISH BRANCH.—129, Bath-street, Glasgow. "Structural Uses of Aluminium and its Alloys," Mr. E. T. Painton. 7.15 p.m.

LIVERPOOL ENGINEERING SOC.—9, The Temple, 24, Dale-street, Liverpool. Joint meeting with Inst. of Electrical Engineers, Mersey and N. Wales (Liverpool) Centre. "Automatic Street Traffic Signalling," Mr. T. P. Preist. 6.30 p.m.

NEWCOMEN SOC.—At Inst. of Structural Engineers, 10, Upper Belgrave-street, S.W.1. "The Origin of the Vacuum Cleaner," Mr. H. C. Booth. 5.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS: GRADUATE SECTION.—Bolbec Hall, Newcastle-upon-Tyne. "The Transmission of Power by Hydraulic Couplings," Mr. Kenneth Fairbairn. 7.15 p.m.

THURSDAY, FEB. 28TH.

INST. OF AUTOMOBILE ENGINEERS.—Red Lion Hotel, Luton. "Small Racing Cars," Mr. H. N. Charles. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, W.C.2. "Private Plants and Public Supply Tariffs," Mr. J. A. Sumner. 5.30 for 6 p.m.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND CENTRE.—In Hall of the Central Technical College, Suffolk-street, Birmingham. Faraday Lecture, "Electricity in the Life of To-day," Professor E. W. Marchant. 6.30 for 7 p.m.

INST. OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH.—Visit to works of Butler Machine Tool Company, Ltd., Halifax, 2.45 p.m. In Lecture Hall of Literary and Philosophical Soc., Halifax. "The Organisation of a Modern Factory Producing Precision Tools," Mr. J. H. Barber. 7.30 p.m.

INST. OF METALS.—James Watt Memorial Inst., Birmingham. "The Rarer Metals—Gold, Silver, and Platinum," arranged by Johnson Matthey and Co., Ltd. 7 p.m.

INST. OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W.1. "Vibration and Pervibration in Concrete Depositing," Mr. T. J. Gueritte. 6.30 p.m.

FRIDAY, MARCH 1ST.

INST. OF FUEL.—At British Industries House Club, Marble Arch, Oxford-street, W.1. Mr. Harold Hobson will open debate on "Is the Expenditure on the Electrical Grid Likely to be Justified?" Mr. W. A. Tookey will be the first speaker for the opposition. 6.30 for 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Informal meeting. Lecture, "Random Notes on Engineering in Greece," Mr. Leslie Turner. 7.30 p.m.

MANCHESTER ASSOC. OF ENGINEERS.—Manchester Limited Restaurant, Royal Exchange, Manchester. Annual dinner and dance. Reception, 7 p.m.; dinner, 7.30 p.m.; dancing, 9.30 p.m. to 1 a.m.

MONDAY, MARCH 4TH.

ENGINEERS' GERMAN CIRCLE.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "The Velox Boiler and its Possibilities as Applied to Land and Sea," Herrn. Adolf Meyer. 5.15 for 6 p.m.

TUESDAY, MARCH 5TH.

INST. OF AUTOMOBILE ENGINEERS.—At Royal Geographical Soc., Kensington Gore, S.W.7. Joint meeting with eleven other technical societies. Symposium. "Cold Pressing and Drawing." Papers: (*a*) "From the Mechanical Point of View," Dr. H. Gough, F.R.S.; (*b*) "From the Metallurgical Point of View," Dr. C. H. Desch, F.R.S.; and it is hoped that Prof. Dr. Ing. G. Sachs will deal with some aspect of the subject. Prof. Sir Harold Carpenter, F.R.S., will take the chair at 7 p.m.

WEDNESDAY, MARCH 6TH.

INST. OF ELECTRICAL ENGINEERS: WIRELESS SECTION.—Savoy-place, W.C.2. "Crystal Oscillators for Radio Transmitters," Messrs. C. F. Booth and E. J. C. Dixon. 5.30 for 6 p.m.

SOC. OF GLASS TECHNOLOGY: LONDON SECTION.—At Offices of Holophane, Ltd., Elvaston-street, Westminster. Symposium, "Stoppers, Caps, and Closures." 7.30 p.m.

WEDNESDAY AND THURSDAY, MARCH 6TH AND 7TH.

INST. OF METALS.—Annual general meeting. For programme see February 8th, 1935, page 148

THURSDAY, MARCH 7TH.

INST. OF CIVIL ENGINEERS: YORKSHIRE AND DISTRICT ASSOC.—Hotel Metropole, Leeds. "Sydney Harbour Bridge," Mr. J. Walton. 7.30 p.m.

FRIDAY, MARCH 8TH.

INST. OF ELECTRICAL ENGINEERS: LONDON STUDENTS.—Savoy-place, W.C.2. "High-voltage Alternators," Mr. P. E. Crawshaw Smith. 6.30 for 7 p.m. Visit to the *Daily Herald* Printing Offices. 10 p.m.

INST. OF ELECTRICAL ENGINEERS: N.-EASTERN STUDENTS.—County Hotel, Neville-street, Newcastle-upon-Tyne. Second annual dinner. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: NORTH MIDLAND CENTRE.—Hotel Metropole, Leeds. Annual dinner. 7 p.m. for 7.30 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. Prof. B. P. Haigh will introduce discussion on "Recent Work in Testing Steel of Mild and Moderate Tensile Strength." 7 p.m.

INST. OF METALS: SHEFFIELD LOCAL SECTION.—At University, Sheffield. "Electric Annealing and Heat Treatment Furnaces," Mr. A. G. Lobley. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Informal meeting, "The Construction of a Modern Liner," Mr. E. H. Brooks. 7.30 p.m.

SOC. OF CHEMICAL INDUSTRY.—In Chemical Dept. of Liverpool University, Liverpool. Symposium on Meat, "The Chemistry of Meat." Papers by Dr. E. C. Smith and Mr. L. C. Baker. 3–5 p.m. "Meat Storage." Papers by Dr. T. Moran and Mr. Hal Williams. 6–7 p.m.

SATURDAY, MARCH 9TH.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOC.—Trocadero, W.1. Annual dinner. Full particulars from F. R. C. Rouse, 15, Clifton-gardens, Golders Green, N.W.11.

MONDAY, MARCH 11TH.

INST. OF METALS: SCOTTISH LOCAL SECTION.—At 39, Elmbank-crescent, Glasgow, C.2. Annual general meeting. Paper, "Welding," Dr. J. H. Peterson. 7.30 p.m.

STEPHENSON LOCOMOTIVE SOC.—King's Cross Station, N.1. "Railway Snapshots: Ancient and Modern," Mr. A. E. L. Thorne. 6.30 p.m.

TUESDAY, MARCH 12TH.

INST. OF METALS: N. EAST COAST LOCAL SECTION.—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-upon-Tyne. Discussion, "The Improvements of White Bearing Metals for Severe Service: Some General Considerations," Mr. D. J. Macnaughton. 7.30 p.m.

INST. OF METALS: SWANSEA LOCAL SECTION.—At Y.M.C.A., Swansea. Annual general meeting. Paper, "Some Recent Developments in the Hardening of Non-ferrous Metals by Heat Treatment," Mr. W. T. Griffiths. 6.15 p.m.

ROYAL AERONAUTICAL SOC.—Joint meeting with the Illuminating Engineering Soc., at Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Recent Developments in the Lighting of Airways and Aerodromes." 6.30 p.m.

THURSDAY, MARCH 14TH.

INST. OF AUTOMOBILE ENGINEERS.—Merchant Venturers' Technical College, Bristol. "Small Racing Cars," Mr. H. N. Charles. 7.30 p.m.

INST. OF METALS: LONDON LOCAL SECTION.—In Rooms of Soc. of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. "Failures in Service," Dr. H. J. Gough, F.R.S. 7.30 p.m.

THE ORIGIN OF THE THRASHING MACHINE.—We have received from William Foster and Co., Ltd., of Lincoln, a copy of an interesting little publication concerning the early history of the thrashing machine, which is a reprint of an article written for the *Lincolnshire Magazine* by Sir William Tritton. The development of the machine is traced back for some 300 years, and considerable detail given for the past 200. The early efforts were apparently made in the North, but East Anglia soon became the most important district for its manufacture until, at the zenith of the trade—between 1906 and 1912—about 7000 sets a year were being made. These machines were valued at £2,300,000, and almost all of them were exported, the home trade amounting to only £55,000 per annum. It will thus be seen how hard-hit has been the industry by the practical extinction of the export trade with the Continent. It is to be hoped that it will revive. Messrs. Foster tell us that they will be pleased to send a copy of the booklet to anyone interested.